FAHCE STEVENS CREEK
FISH PASSAGE ENHANCEMENT

Project No. 00294001

FINAL PLANNING STUDY REPORT

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Existing Denil Fish Ladder
at **Moffett Boulevard**

Existing Denil Fish Ladder
at **Evelyn Avenue**

Existing Denil Fish Ladder
at **Fremont Avenue**

Proposed Multi-Port Outlet at **Stevens Creek Dam**

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EXECUTIVE SUMMARY

Introduction and Problem Definition

The problem of land development and water supply operations causing insufficient freshwater habitat for fish is widespread. The common problems for fish in Santa Clara County's watersheds are barriers to fish migration; warm stream temperatures; and reduced or fluctuating stream flows due to reservoir operations.

The local creeks and rivers also have been affected by a century of land development and water facility construction. Intense winter storms may occasionally fill or even flood the country's rivers and creeks, but generally it is the controlled releases of water from reservoirs—along with subsequent usage of that water—that determines stream flow levels. Water District operations direct a large portion of stream flow to treatment plants or into groundwater recharge ponds. Although mandated by the State Water Resources Control Board, water appropriations for continued protection of fisheries are limited—in balance with other public interests in the water resource. Biotic conservation interests include management of other aquatic and semi-aquatic species such as turtles and frogs.

In July 1996, the Guadalupe-Coyote Resource Conservation District (GCRCD), Trout Unlimited and the Pacific Coast Federation of Fisherman's Association filed a complaint with the State Water Resources Control Board. The complaint challenged the exercise of the water rights of the Santa Clara Valley Water District, on the basis that Water District operations were not providing adequate flows for the protection of fisheries and other aquatic resources in three specific streams: Coyote Creek, Stevens Creek and the Guadalupe River. In early 1997, the Water District and the California Department of Fish and Game initiated a "Fisheries and Aquatic Habitat Collaborative Effort (FAHCE)," which includes federal, state and local stakeholders. A Fish Habitat Conservation Plan for the three subject watersheds was developed, for the purpose of seeking to balance and integrating all beneficial uses of the local water source (including drinking water, flood protection, recreation and fisheries).

Since development of the FAHCE program, only a limited number of projects identified in FAHCE has been implemented, pending completion of the permitting processes. However in the interim, the FAHCE Consensus has requested the Water District to be proactive in determining which "early implementation" projects could be undertaken pending full implementation of the program. The Water District has chosen locations within Stevens Creek to address the interim request.

Stevens Creek has been identified as one of prime steelhead habitat within the county. Improving fish passage within the Stevens Creek corridor will promote and enhance the existence of steelhead and other salmonid species.

The existing Denil-type fish ladders at Fremont Avenue, Evelyn Avenue, and Moffett Boulevard are located in sections of Stevens Creek where summer flows are very limited. In most cases, for the Fremont and Evelyn sites, there may be no flows at all during the summer seasons.

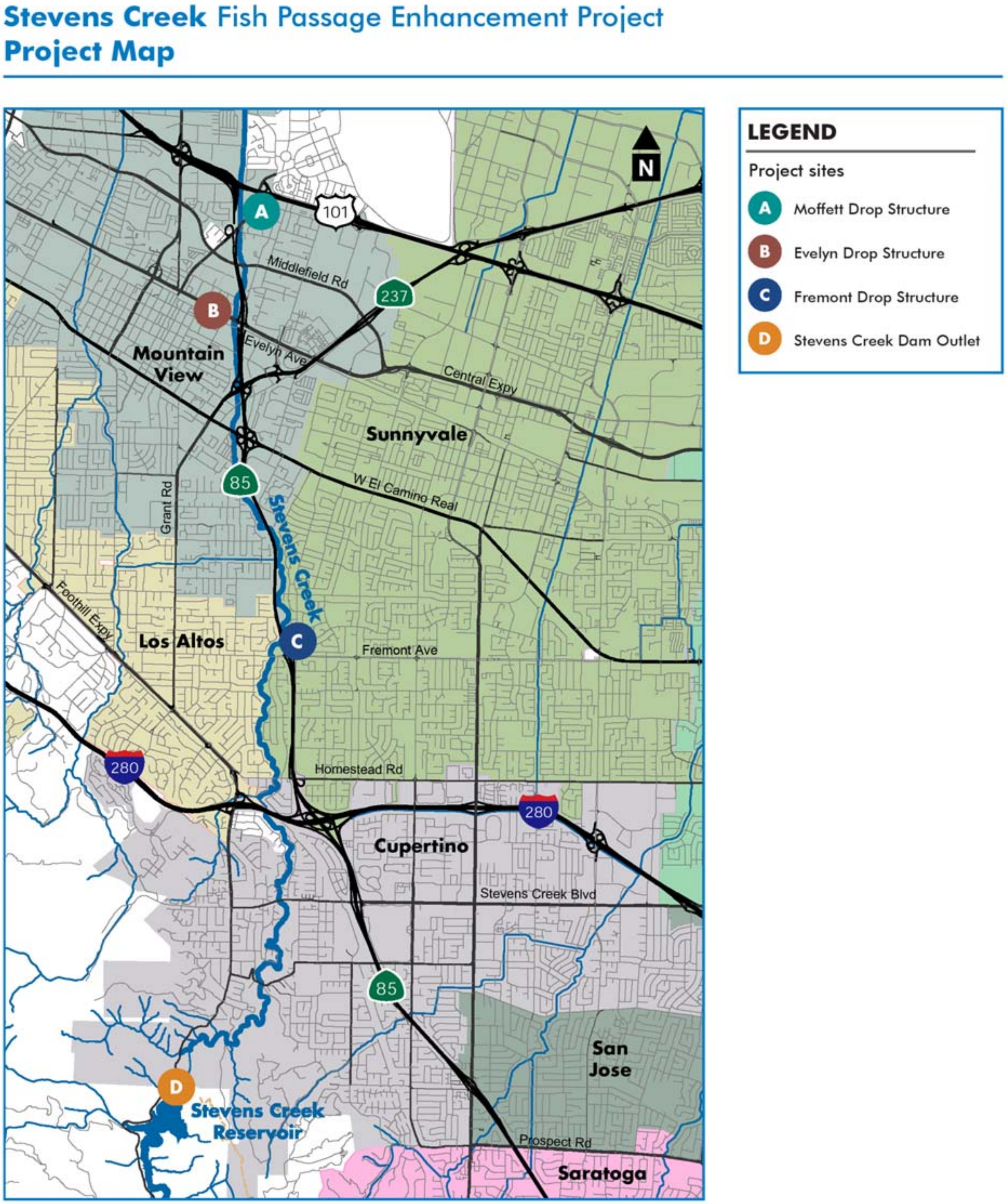
In the past, the California Department of Fish and Game (CDFG) approved the design and installation of various Denil-type fish ladders throughout the state. However, based on current standards, CDFG does not consider Denil-type fish ladders as effective passage for migrating fish, and at times, considers these particular fish ladders as partial barriers. Denil-type fish ladders tend to accumulate debris and require frequent maintenance to prevent such accumulations.

Limited summer flows are due primarily to the limited flow releases from Stevens Creek Reservoir. Current flow releases from Stevens Creek Dam do not follow a sufficient cold water management plan to optimally support fish habitat. The cold pool volume of the reservoir released during the summer season from a single bottom outlet is of limited management flexibility. This situation merits investigation into the potential to increase the effective cold pool volume with operational appurtenances having improved performance and better optimization, to allow for a wider suite of water management objectives.

This project proposes to improve fish migration conditions for the three fish ladder sites at Fremont Avenue, Evelyn Avenue, and Moffett Boulevard. Additionally, this project will efficiently increase usable reservoir water from Stevens Creek Dam to enhance fishery habitat downstream of the dam and to supplement current groundwater operations.

Figure 1 shows the location of the four sites of concern.

Figure 1 - Location Map



Santa Clara Valley Water District

Project Objectives

The following project objectives were established by staff and used to develop alternatives for this project:

1. Meet the District's mitigation and conservation obligation resulting from the FAHCE-Draft settlement.

2. Provide adequate passage for both adult and juvenile steelhead by restoring and maintaining a healthy stream that allows for suitable spawning and rearing habitat.

3. Improve fish passage conditions without adversely affecting other wildlife species.

4. Remove existing fish barriers and provide adequate maintenance access to ensure that fish passage at structures are not impeded.

5. Implement fish passage designs that do not adversely affect the flood protection capacity of the existing channel.

Project Alternatives

For each fish ladder site, three feasible alternatives were developed and evaluated, besides the no-project option. Alternatives ranged from minor modification to the existing facility, more aggressive structural solutions and finally, naturalistic options. For Stevens Creek Reservoir and Dam, two alternatives were evaluated, which included the no-project and multiport intake structure options. All feasible alternatives must comply with the project objectives. Each alternative was then ranked based on project construction and maintenance cost, maintainability and operability of the facility, ability of improved facility to provide passage to other wildlife species, flood impact implication, geomorphic enhancement, community impacts, constructability, potential lifespan of the facility, and aesthetics. The highest rated alternative for each site was selected as the staff-recommended alternative for that site. Final resource agency consensus of the preferred alternatives will have to be obtained for permitting approval and during development of the CEQA for the project.

Public Outreach

Community feedback and support were actively sought during the project planning process. A stakeholder meeting, consisting of representatives from Guadalupe-Coyote Resource Conservation District, Stevens and Permanente Creek Watershed Council, and Santa Clara County Creeks Coalition, was held on April 27, 2009 to discuss the problems with the four sites, present conceptual alternatives to solve the problems, and obtain feedback from all internal and external contributors. Resource agencies, as well as, other local stakeholder groups were invited, but were not available to attend the meeting.

Since the stakeholder meeting of April 27, most of the comments received by phone from the public (including the City of Mountain View, City of Sunnyvale, and residents who live adjacent to the Fremont Avenue drop structure) relate to the proposed scour pool and weir option. The Fremont Avenue scour pool and weir option would require the removal of approximately 100 riparian trees. The majority want to retain most of the vegetation within the area. Therefore, they would likely be against the scour pool and weir option.

A general public meeting was conducted on November 12, 2009 to present the Water District's planning process for development of the feasible and staff-recommended alternatives. Although only three people from the community attended the meeting, feedback from them was a unanimous acceptance of the staff-recommended alternatives.

Staff-Recommended Alternatives

After evaluating the feasible alternatives, engagement with the community, and feedback from the citizens, local stakeholder groups and resource agencies, District staff identified the following alternatives for the three fish ladder sites and Stevens Creek Dam and Reservoir:

- Moffett Boulevard – Low flow channel option, which includes the retention of the existing fish ladder structure, construction of a natural ramp for other wildlife species, and the construction of a low-flow channel downstream of the existing Denil fish ladder downstream to U.S. 101
- Evelyn Avenue – Scour pool and weir option, which is a natural alternative
- Fremont Ave – Vertical slot fishway option, which is a structural alternative
- Stevens Creek Dam and Reservoir – Multiport intake option

The multiport intake option, which is the only alternative evaluated versus the no project option, received the higher rating. However, although the multiport intake option was selected for Stevens Creek Dam and Reservoir from this study, the Permanent Supplemental Water Supply Systems Project would also evaluate the potential modifications to Stevens Creek Reservoir operations. Therefore, staff recommends that implementation of the multiport intake option be postponed until further evaluation of the other project. The multiport intake option may be included as part of the new project. Further details regarding each of the options listed can be obtained in Chapters 3 and 4 of this report.

Estimated Capital Design and Construction Costs and Schedule

Table 1 presents the estimated design and construction costs for the staff-recommended alternatives.

Project design would be conducted in two phases within two years—the first phase for the fish ladders and the second one for the multiport outlet structure. Staff would start the design and CEQA process upon Board of Directors (Board) consideration to adopt a resolution to proceed with the project. Construction would also be conducted in two phases within two years—the first phase for the fish ladders and the second one for the multiport intake structure. Construction of the multiport intake structure project may best be accomplished if it co-occurs with other major work at the dam or outlet, but that detail is not part of the scope of this study. Doing so would result in cost consolidation with other potential necessary work and reduced facility service outage.

Table 1. Estimated Design and Construction Costs

	Moffett	Evelyn	Fremont	Stevens Dam	**Total**
Design	$ 0.2M	$ 0.3M	$ 0.2M	$ 0.2M	**$ 0.9M**
Construction	$ 1.0M	$ 1.3M	$ 0.8M	$ 0.3M	**$ 3.4M**
Total	**$ 1.2M**	**$ 1.6M**	**$ 1.0M**	**$ 0.5M**	**$ 4.3M**

Long-Term Operational and Maintenance (O&M) Costs

O&M costs savings would pertain to the improvement of the fish ladders, not the multiport outlet structure. The multiport outlet structure would indirectly increase the Water District's groundwater supply and enhance stream and water quality habitat downstream of Stevens Creek Dam.

The completion of this project is anticipated to decrease O&M costs by approximately $12,000 per year beginning in FY 2013, due to reductions in routine maintenance and debris removal.

Project Financing

The proposed design and construction for the project would be financed ninety percent by the Water Utility Enterprise (FAHCE Program) and ten percent by the Watershed Stream Stewardship Fund.

Right of Way

Project construction of the Moffett Boulevard low-flow channel will be implemented within a portion of City of Mountain View lands, of which the Water District currently has permanent easement rights. Modification to the existing permanent easement will be required prior to construction of the low-flow channel.

Construction of the scour pool and weir alternative at Evelyn Avenue will be implemented within City of Mountain View lands, of which the Water District currently has permanent easement rights. Modification to the existing permanent easement will be required prior to construction of this alternative. Additionally, the project requires modifications over a portion of the existing foundation of the Union Pacific Railroad. To obtain approval of foundation modifications, an encroachment permit will have to be obtained from the Peninsula Corridor Joint Powers Board, which oversees the operations of Union Pacific Railroad.

Construction of the vertical slot fishway alternative at Fremont Avenue will be implemented within City of Mountain View and City of Sunnyvale lands, of which the Water District currently has permanent easement rights. Modification to the existing permanent easement will be required prior to construction of this alternative.

Construction of the multiport intake structure will occur within Water District right of way. Additional right of way is not required.

Implementation of Staff-Recommended Alternatives

The California Environmental Quality Act (CEQA) analysis for this project would be incorporated into the Environmental Impact Report (EIR) prepared for the Three Creeks Habitat Conservation Plan (HCP) for Water Supply Operations. This EIR is expected to be certified by the Board in July 2010. Construction of the project would not occur until EIR certification is achieved.

If the Board directs staff to proceed with the project, the following tentative milestones have been developed as the next steps toward project implementation (these dates are preliminary and are subject to change):

- Completion of Draft Three Creeks EIR (by others): December 2010

- Board Certification of Three Creeks EIR: July 2011

- Complete fish ladders plans and specifications: February 2012
- Board approval of fish ladder plans and specifications: March 2012
- Begin construction for fish ladder sites: June 2012
- Complete multiport intake plans and specifications (if decided that this is the solution): February 2013
- Board approval of multiport outlet plans and specifications: March 2013
- Begin construction of multiport intake: June 2013 (or when synchronized with other major work on the outlet structure).

1.0 PROJECT BACKGROUND

1.1 Project Overview

During 2008, the FAHCE Consensus initiated a request to the District Board regarding potential early implementation of improvements to fish passage within the County. Since development of the FAHCE program, only a limited number of projects identified in FAHCE has been implemented, pending completion of the permitting processes. However in the interim, the FAHCE Consensus has requested the Water District to be proactive in determining which "early implementation" projects could be undertaken pending full implementation of the program. The Water District has chosen locations within Stevens Creek to address the interim request.

Water District staff has identified three existing fish ladders within Stevens Creek that require modification or replacement to improve fish passage condition for steelhead. These three sites are located downstream of Moffett Boulevard, downstream of Evelyn Avenue, and downstream of Fremont Avenue. During the early years of the FAHCE development (circa 1996), these three sites were some of the few locations prioritized to be modified for fish passage improvement. All these fish ladders are located within existing drop structures. Additionally, staff has decided to determine the feasibility of incorporating a multiport intake structure upstream of the dam. Incorporating a multiport intake may increase the flow releases from the reservoir during the summer season without impacting the thermal thresholds prescribed by FAHCE for the Stevens Creek corridor. Increasing the flow from the dam would enhance the quality of wildlife habitat for Stevens Creek and consequently increase the potential water recharge to groundwater.

As part of the planning phase for the project, staff has conducted the following actions before selecting the final staff-recommended alternatives:

- Determined the existing problems and opportunities for each site.
- Obtained feedback from specific stakeholders who would be most impacted by any work done to the functional improvements of the facilities. These included resource agencies and environmental third-party organizations.
- Developed feasible alternatives based on addressing the main problems and specific stakeholder feedback.
- Narrowed the feasible alternatives via a criteria and ranking process for selecting the initial staff-recommended alternative for each facility.
- Obtained feedback from the general public before finalizing the staff-recommended alternatives.

1.2 Purpose of the Planning Study Report

This Planning Study Report serves as a basis for the Board to determine whether or not to adopt a resolution to consider undertaking the design and construction for the project. If the Board provides preliminary approval of the project by adopting a resolution, staff will continue with preparing design plans and specifications and will complete the environmental impact analysis and documentation.

1.3 Goals and Objectives

It is the mission of the District to provide a healthy, safe, and enhanced quality of living in Santa Clara County, through watershed stewardship and comprehensive management of water resources in a practical, cost-effective and environmentally sensitive manner.

The following project objectives were established by staff and used to develop alternatives for this project:

1. Meet the District's mitigation obligation resulting from the FAHCE settlement.
2. Provide adequate passage for both adult and juvenile steelhead by restoring and maintaining a healthy stream that allows for suitable spawning and rearing habitat.
3. Improve fish passage conditions without adversely affecting other wildlife species.
4. Remove existing fish barriers and provide adequate maintenance access to ensure that fish passage at structures are not impeded.
5. Implement fish passage designs that do not adversely affect the flood protection capacity of the existing channel.

1.4 Cities Within the Project Areas

The Moffett Boulevard and Evelyn Avenue structures lie within the City of Mountain View. There are existing trails adjacent to the existing structures. These trails may be temporarily impacted during construction operations. However, from a long term perspective, these trails would remain intact.

Within the City of Sunnyvale, there are future plans to incorporate a trail element near the Fremont Avenue structure. However, plans for this trail are still in the planning stage and a final decision has not been made.

1.5 The Recommended Capital Improvement Project

After evaluating a thorough range of alternatives, including several alternatives that met the project objectives, this report recommends a capital improvement project to be designed and constructed. The recommended project would improve fish passage and other wildlife habitat for the Stevens Creek corridor.

A summary of the staff-recommended alternatives is provided below.

- For Moffett Boulevard, the low flow channel option was selected, with retention on the existing fish ladder structure, and the construction of a natural ramp on the westerly slope of the drop structure and a low-flow channel downstream of the existing Denil fish ladder downstream to U.S. 101. This option is a structural alternative.

- For Evelyn Avenue, the scour pool and weir option was selected. This option is a naturalistic alternative.
- For Fremont Avenue, the vertical slot fishway option was selected. This option is a structural alternative.
- For Stevens Creek Dam and Reservoir, the multiport intake option was selected.

Although the multiport intake option was selected for Stevens Creek Dam and Reservoir, FAHCE proponents are seeking other alternatives. Therefore, staff recommends that implementation of the multiport intake option be postponed until adequate evaluation of other alternatives. Further details regarding each of the options listed can be obtained in Chapters 3 and 4 of this report.

2.0 PROBLEM DEFINITION

2.1 Moffett Boulevard Drop Structure

Identified Functional Problems

The drop structure between U.S. 101 and Moffett Boulevard has a Denil-type fish ladder on the easterly side of the drop structure (see Figure 2). The Denil-type fish ladder for this section is obsolete based on current fish passage standards. Denil-type fish ladders are now considered by CDFG and National Marine Fisheries Service (NMFS) to be partial barriers, due to the fact that blockage can and does occur within and above the steel weir structures of the fish ladder, rendering the ladder impassable. When blockage for this area occurs, there is limited access from the top of bank to remove the blockage with a long-pronged manual equipment (see Figure 2). In addition to the obsolete Denil-type fish ladder, there are other identified fish passage problems at this site:

- The existing drop structure, which is a hardscape element that was built in the early 1980s, is considered an eyesore by most resource agencies. Although its fundamental function fully serves its hydraulic purpose, its hardscape elements do not conform to the natural landscape of the river corridor.

- The pool immediately downstream of the Denil-type fish ladder naturally accumulates with sediments (see Figure 2). Its effectiveness as a fish attractant pool is not realized.

- The existing concrete-lined channel extending from immediately downstream of the drop structure to Highway 101 (a distance of 450 feet) is flat (see Figures 3 and 4). Low-flows emanating from the drop structure will flow as a thin sheet of water over the concrete bottom. At least 8 inches depth of flow are required for adequate fish passage.

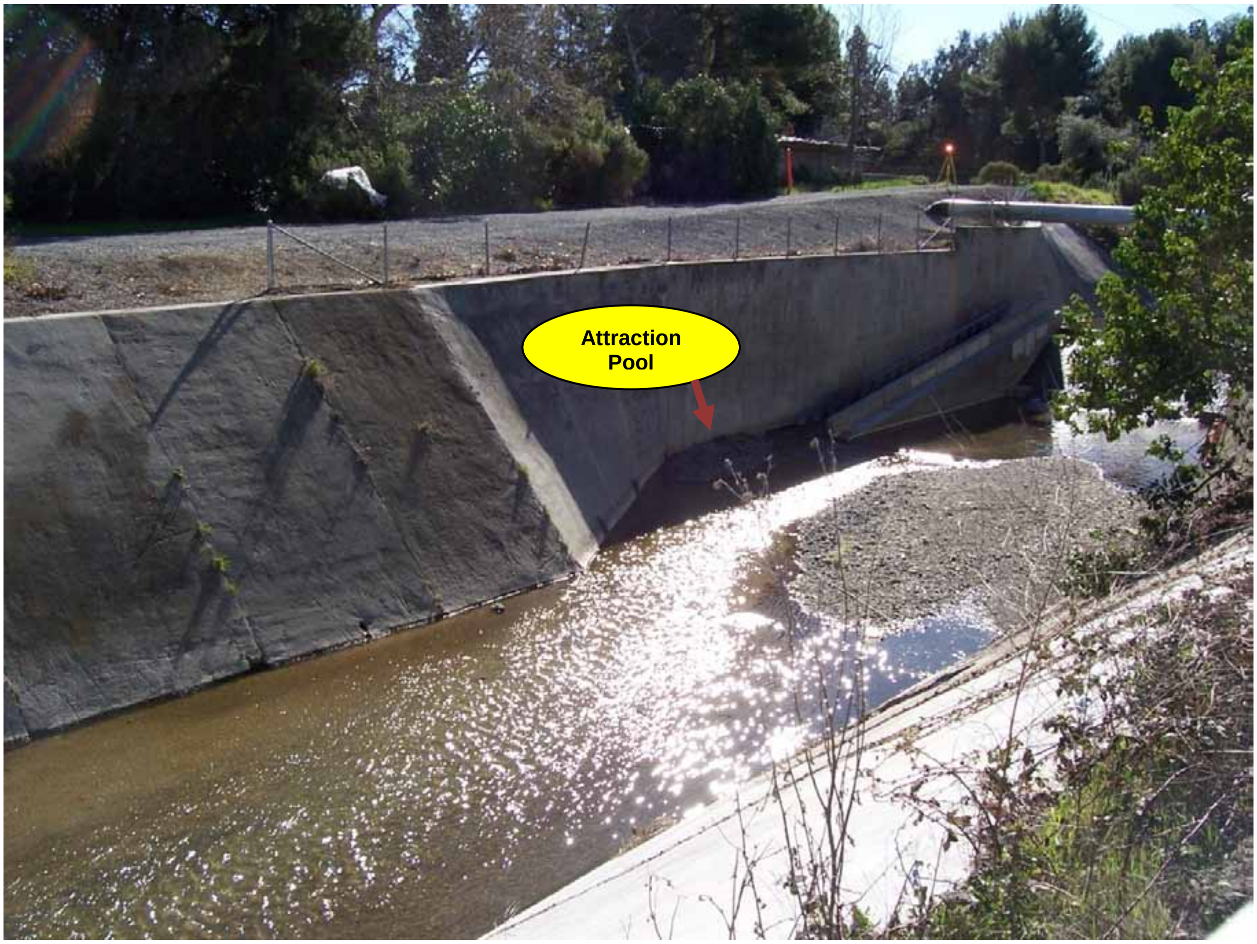
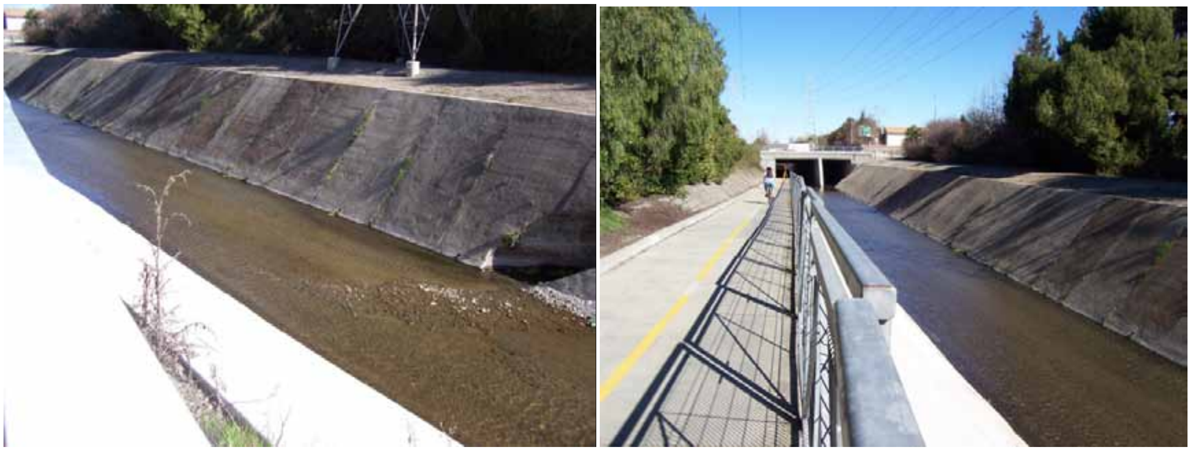


Figure 2. Moffett Boulevard Fish Ladder (Looking Southeasterly)



Figures 3 & 4. Existing channel from fish ladder to U.S. 101

2.2 Evelyn Avenue Drop Structure

Identified Functional Problems

This particular location also has a Denil-type fish ladder immediately downstream and westerly of the Union Pacific Railroad (UPRR) crossing (see Figure 5). There are other fish passage problems identified at this site:

- A concrete box culvert, which was constructed in the early 1980s, crosses below Evelyn Avenue, UPRR, the VTA tracks, and Central Expressway (see Figures 6 to 8). The upstream end of the box culvert was previously designed, so low-flows would follow the path of the natural channel—the original concrete invert entrance of the box culvert was designed to be 2 feet above the natural invert of the natural channel. However, instead of the box culvert acting as a secondary route for higher flows, it is now acting as the primary route for low-flows, with the main creek as a secondary route.

- An existing obsolete gaging weir just upstream of the UPRR crossing can cause minor impediment to fish passage (see Figure 9).

- The arched foundation below the Union Pacific Railroad tracks is designed to fully support the railway system (see Figure 5). The six-foot drop below this foundation system causes an impediment to fish passage. Requesting UPRR to significantly modify their foundation would be difficult and likely be impossible.

- The recently added VTA Light Rail crossing further restricts maintenance access from top of bank and possibly provides additional channel restriction, reducing channel and ladder function for fish passage.

- The pool immediately downstream of the Denil-type fish ladder naturally accumulates with sediments. Its effectiveness as a fish attractant pool is not realized (see Figure 10).

- The concrete slabs and rocks downstream of the intended fish-attractant pool has no defined low-flow channel (see Figure 11). A stream must have a continuous and well defined low-flow channel to ensure fish migration through a channel's corridor.

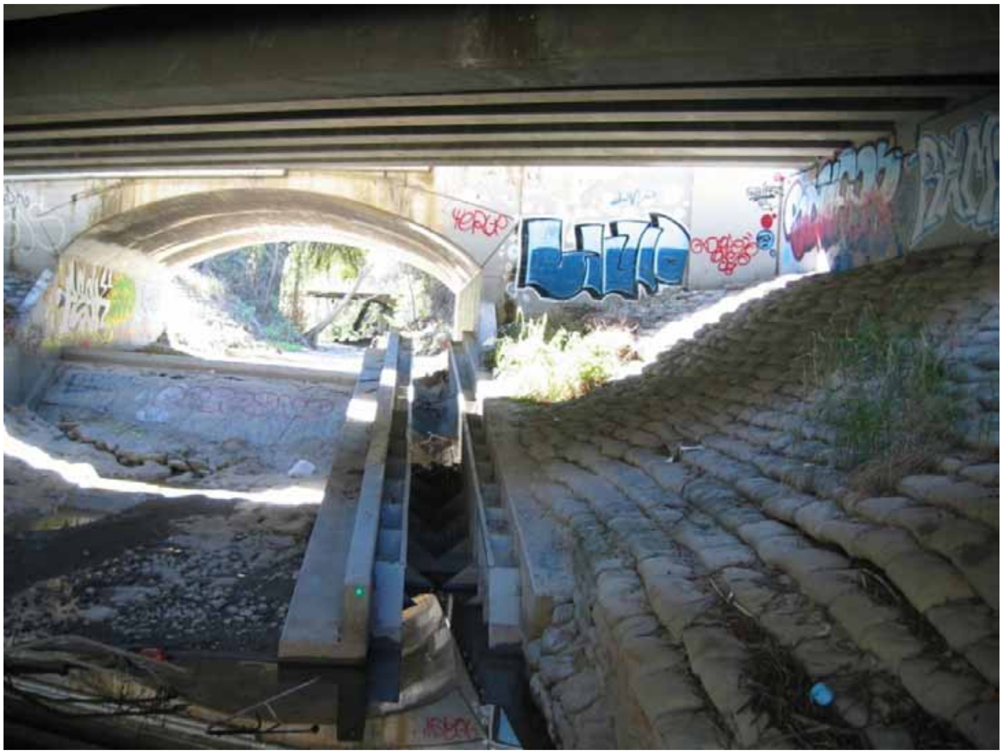
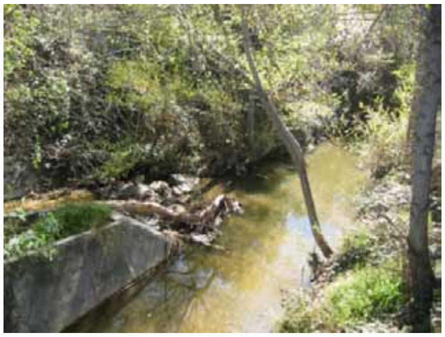


Figure 5. Evelyn Avenue Fish Ladder (Denil Structure Downstream of UPRR Crossing)



Figures 6, 7, and 8. Evelyn Avenue Fish Ladder
(Looking U/S, inside, and D/S of Box Culvert, Respectively)

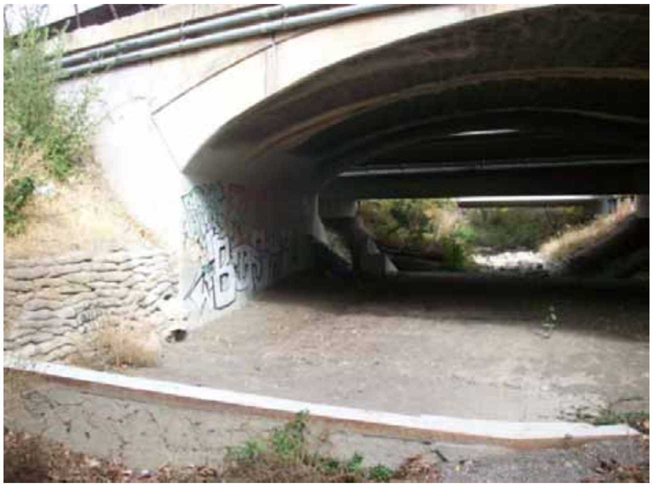


Figure 9. Evelyn Avenue Fish Ladder (Looking D/S at Obsolete Gaging Weir)

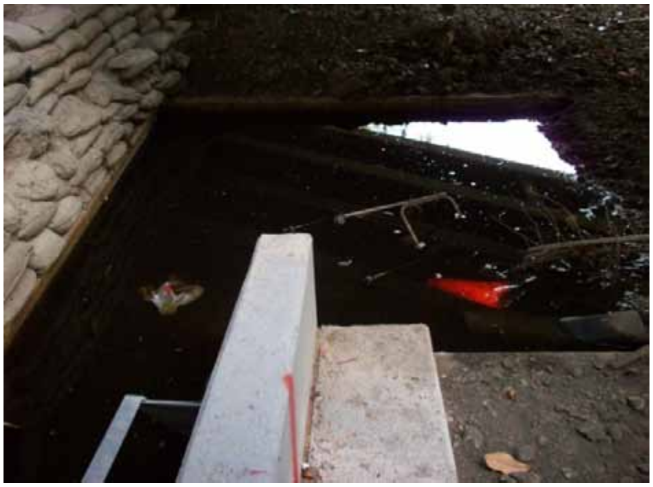


Figure 10. Evelyn Avenue Fish Ladder (Looking at Fish Attractant Pool)

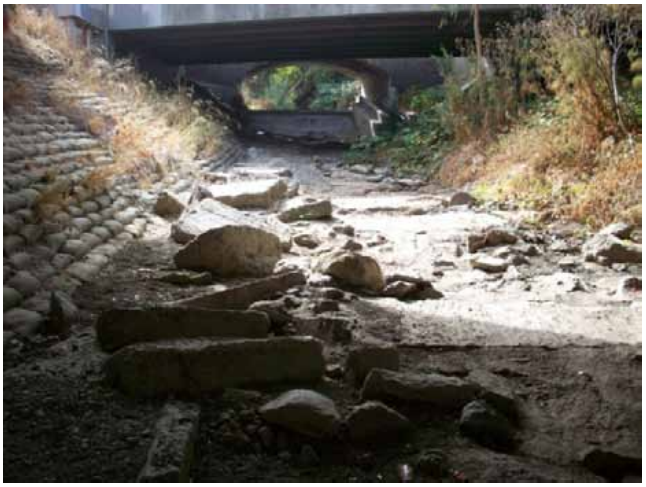


Figure 11. Evelyn Avenue Fish Ladder
(Looking at Concrete Slabs and Rocks Downstream)

2.3 Fremont Avenue Drop Structure

Identified Functional Problems

The existing fish ladder for this site is located in the inside portion of a bend, where upstream of the bend, sediments would normally accumulate—thus, partially blocking the entrance/exit at the top of the fish ladder (see Figure 12). This particular location also has a Denil-type fish ladder. When blockage for this area occurs, there is no adequate operational access to remove the blockage (see Figure 13). In addition to the obsolete Denil-type fish ladder, there are other identified fish passage problems at this site:

- Immediately downstream and westerly of the concrete drop structure, the existing channel has been undermined, possibly due to excessive stream velocities (see Figure 14). The length of undermining is approximately 30 feet. The existing slope protection boulders within the vicinity of the undermined area have been carried downstream by high flows, and portions of the existing channel bottom are exposed down to 4 to 5 feet deep.

- The existing drop structure, which is a hardscape element that was built in the early 1980s, is considered an eyesore by most resource agencies. Although its fundamental function fully serves its hydraulic purpose, its hardscape elements do not conform to the natural landscape of the river corridor.

- There is no defined low-flow channel downstream of the structure. A stream must have a continuous and well defined low-flow channel to ensure fish migration through a channel's corridor.

- The concrete chute shows substantial erosion along the top side panel and along the floor. Baffle plates within the chute are demonstrating substantial wear. Wear and tear on the existing chute will likely continue and require substantial accelerated maintenance to retain existing functionality.

- Erosion is evident on the channel armoring downstream of the drop structure. This may require additional maintenance in the future to ensure against bank failure in this incised channel reach.

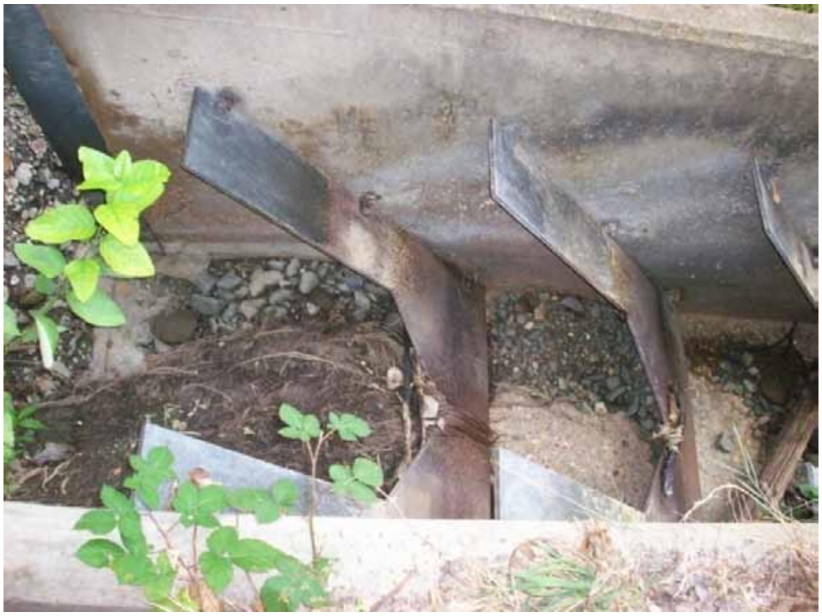


Figure 12. Fremont Avenue Fish Ladder (Top of Denil Structure)

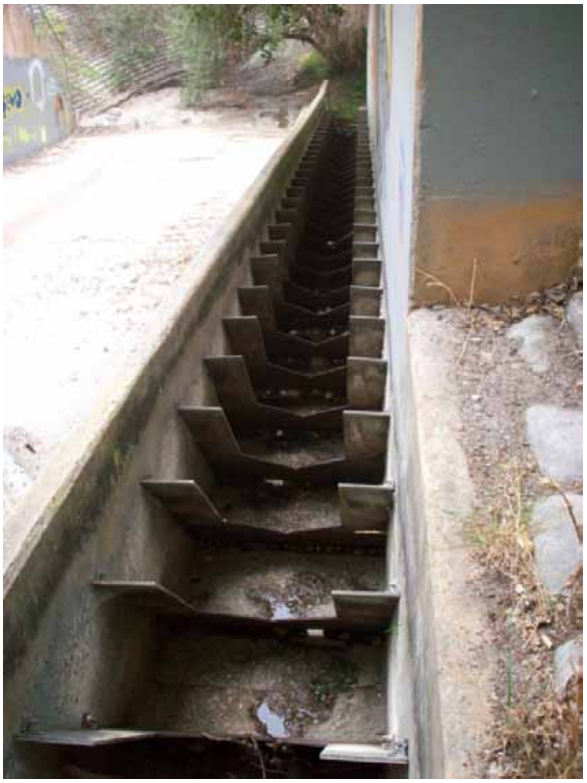


Figure 13. Fremont Avenue Fish Ladder (Looking Downstream at Denil Structure)
Site access to remove blockage is difficult during winter, high flow conditions.

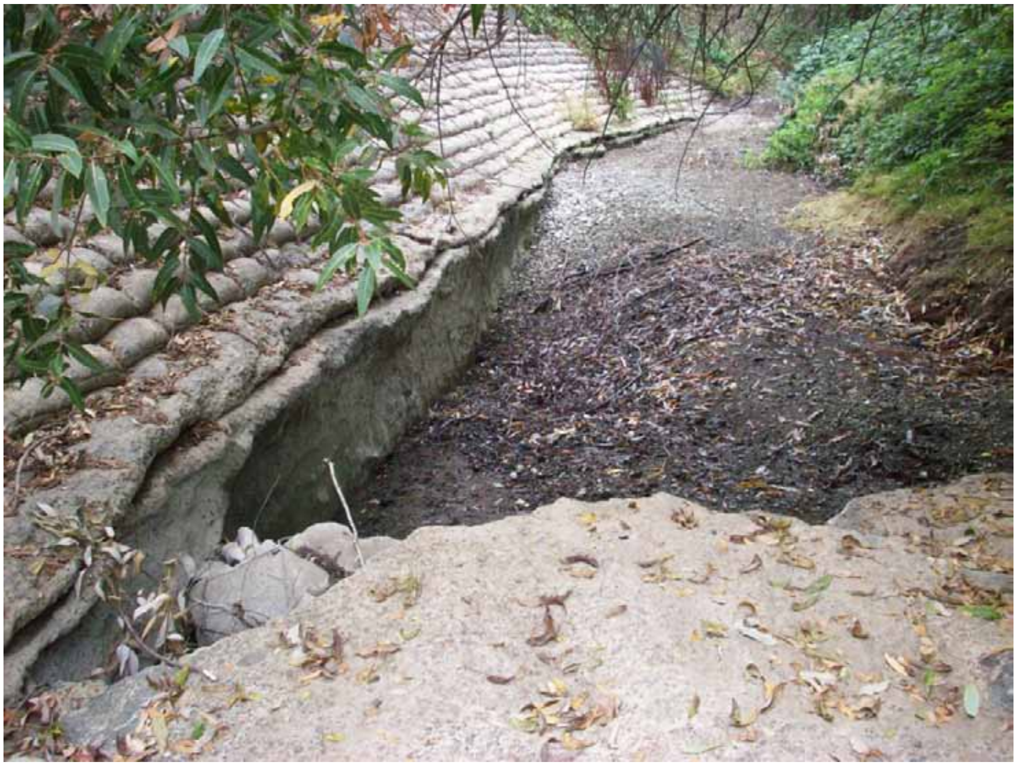


Figure 14. Fremont Avenue Fish Ladder (Downstream of Drop Structure)

2.4 Stevens Creek Dam and Reservoir Multiport Intake Structure

Identified Functional Problems

Stevens Creek Reservoir operations include release of water for groundwater recharge within the Stevens Creek stream bed. During warmer months, the reservoir thermally stratifies, with the bottom cold hypolimnion layer overlain by the warm epilimnion layer (see Figure 15). This stratified condition is typically initiated in April, and extends until fall, when turnover and mixing occur with the onset of cooler water and reduced insulation. Complex interactions of energy input from sunlight, the balance of inflow and outflow, mixing by wind across the reservoir fetch, and internal turbidity conditions from phyto- and zooplankton blooms, suspended sediment, and other factors drive the extent of the stratification each year. The stream temperature downstream is reflected by this stratification. The outlet at the bottom of the reservoir releases cold water until the hypolimnion layer is exhausted. The warmer, upper epilimnion layer is then drained through the outlet, and the stream below the reservoir can warm rapidly, thus endangering the fishery and other wildlife habitat.

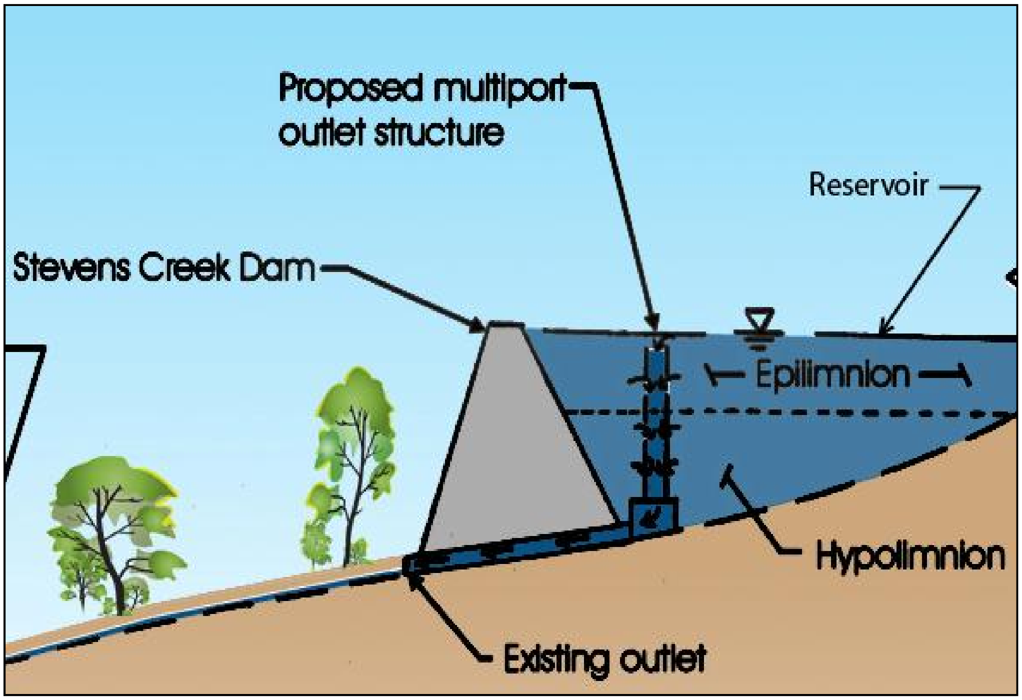


Figure 15. Summer conditions at Stevens Creek Reservoir

Identified Fish Passage Problems

The Fisheries and Aquatic Habitat Collaborative Effort Technical Advisory Committee (FAHCE-TAC) identified a limited opportunity for summer temperature management downstream of the reservoir, based on the relatively small storage capacity of the reservoir and the thermal stratification of this facility. With a single outlet at the bottom of the reservoir, the amount of available water to manage stream temperature downstream of the dam, to provide cooler habitat for cold-water fish such as steelhead trout, is limited. The in-stream recharge, constrained by fish habitat management objectives, relies solely on this limited water source during summer months. This limited water source may only be up to half of the total storage volume of the reservoir. The total volume of the reservoir is not fully utilized for both these water management objectives.

The regulatory agencies, being concerned with conservation of steelhead trout (which is a species listed as “Threatened” under the Federal Species Act), restrict water release from the reservoir under a cold water scenario. Warm water releases are thought to create undue physiological stress on cold water fish in the system.

Volume releases from the reservoir may be better optimized if the warm water could be blended with the cold water, to extend the effective volume of the “cool” water, while staying within the stream temperature targets for summer habitat management in the stream.

3.0 DEVELOPMENT OF PROJECT ALTERNATIVES

3.1 Methodology for Alternatives Development

The methodology used for determining a range of alternatives to evaluate in this planning study was developed in response to the following factors, which are further described below:

1) Project Objectives
2) Feasibility Assessment Factors

3.1.1 Project Objectives

This information is described under **Article 1.3, Goals and Objectives**.

3.1.2 Feasibility Assessment Factors

Conditions affecting the feasibility assessment of each alternative were considered and helped shape the proposed alternatives included in this report. These include:

For fish ladder structures

- Project cost
- Maintainability and operability
- Ability of structure to provide passage for other wildlife species
- Flood capacity impact
- Geomorphic enhancement
- Community impacts
- Constructability
- Potential lifespan of facility
- Aesthetics

For the multiport structure

- Project Cost
- Water availability for fish passage and groundwater recharge
- Opportunity to construct similar structure in other dams
- Cost priority to construct structure versus other considerations to benefit similar area

These items are further described below.

3.1.3 Rating Guidelines

The maximum rating for each item is 10 (on a scale of 0 to 10, in whole numbers, with 0 being least desirable and 10 being most desirable). These are the guidelines used for Tables 1 to 4.

1. Project cost—this rating includes both estimated construction and 30-year cycle maintenance costs. Rating is based on the combined costs.

Cost ($ mil)	Rating
< 0.5	10
0.5-1.0	9
1.0-1.5	8
1.5-2.0	7
2.0-2.5	6
2.5-3.0	5
3.0-3.5	4
3.5-4.0	3
4.0-4.5	2
4.5-5.0	1
> 5.0	0

2. Maintainability and operability—this rating is based on maintenance frequency and accessibility to operate the structure (including the need to rescue fish due to potential stranding occurrence).

If the alternative allows 100% upstream and 100% downstream migration of fish without requiring extensive operation and maintenance (meaning one full-cycle operation and maintenance within a year), then it can have a high rating up to 10. If the alternative requires two times operation and maintenance each year, then the rating would be moderately reduced, potentially down to 5. If the alternative requires more than two times visit to improve fish passage conditions, including rescue operations due to fish stranding occurrences, then the rating would be drastically reduced, potentially down to 0.

3. Ability of structure to provide passage for other wildlife species—this rating is based on how likely the alternative will allow adequate passage for other wildlife species, which is one of the objectives of this project.

If the alternative allows 100% unimpeded passage of other wildlife species, such as pond turtles and red-legged frogs, then a maximum rating of 10 can be applied. However, if the alternative poses as a partial barrier to these species or may only allow some of the species to migrate, then a maximum rating of 5 can be applied. If the alternative poses a significant barrier, a condition where most of the other species would have to look for other high risk routes to migrate, then the rating would be drastically reduced to 0.

4. Flood capacity impact—this rating is based on how likely an alternative could worsen the facility and limit flood capacity of the channel.

If the alternative has 0 potential for reducing flood capacity, then a maximum rating of 10 would be allowed. If the alternative has the potential to moderately reduce flood capacity, the rating likewise would moderately be reduced. If the alternative has a high potential to reduce flood capacity, the rating could be drastically reduced down to 0.

5. Geomorphic enhancement—this rating is based on the potential for the alternative to reduce occurrence of long term erosion.

If the alternative can significantly reduce long term erosion, thereby maintaining its integrity, as well as, future stability of the surrounding ecosystem, its rating could be up to 10. If the alternative, after built, maintains the current likelihood or quasi-status of the existing channel (no reduction or inducement to erosion), then its rating would be 5. If the alternative has the *likely* potential to induce erosion, then its rating would be reduced to 0.

6. Community impacts—this rating is based on a combination of existing vegetation and future trail impacts.

If the alternative has no adverse impacts to existing vegetation and any future trails, its rating could be up to 10. If the alternative negatively impacts one or the other—existing vegetation or future trail—the rating could approximately be 5. If the alternative negatively impacts both existing vegetation and any future trail, then the rating could be as low as 0. Increasing the rating from 0 could be done by mitigating the impact. For each mitigation of a negative impact, the maximum offset positive rating would be 3. The reason for a maximum of 3 points is due to consideration for increase in project cost to satisfy any applied mitigation.

7. Constructability—this rating is based on construction access to the site, as well as, complexity in constructing the alternative.

The more difficult the access to the site, the lower the rating assigned, if more materials are required to be moved to and from the site, including more excavation and fill to construct the alternative. If access is not difficult, the rating could be up to 10. This rating also depends on the complexity of constructing the alternative. The more complex the alternative in constructing, the lower the rating to be assigned. The less complex, the higher the rating.

8. Potential lifespan of facility—this rating is based on likely expectation of the alternative structure's integrity and expected long term outcome after construction.

Based on historical records, comparing to other similar structures that were built in the past, how likely will the structure be sustainable? Would the structure require further modifications long term or is there enough historical basis to support the function and integrity of the structure? If historical conclusion is lacking or the structure is likely to be experimental in nature, then a lower rating would be assigned. If historical records show the structure would likely function long term, without anticipation for further modifications, then a higher rating would be assigned.

9. Aesthetics—this rating is based on how the alternative conforms to the existing creek environment and surrounding neighborhood community.

If the alternative would likely beautify or enhance the existing area, then a rating of up to 10 can be assigned. If the alternative devalues or worsens the existing area, then a rating as low as 0 can be assigned. However, if this negative impact can be mitigated, to where the alternative can somewhat conform to the existing area, then a rating of approximately 5 can be assigned.

3.2 Conceptual Alternatives Analysis

For each of the three fish ladder sites, besides the no-project alternative, three other alternatives were considered. Only one alternative, besides the no-project alternative, was considered for the multi-port intake structure.

Tables 1 thru 4 provide the feasibility alternatives matrices, along with the rating summaries for each of the alternatives. The rating guidelines identified from Article 3.1.3 were used to develop information for the summaries. These summaries were derived from an average compilation of ratings obtained from pertinent Water District staff members who have direct involvement with the future planning, design, construction and maintenance of these facilities. These include the following staff members:

Jae Abel, John Pfister, Liang Xu, Carol Fredrickson, Chad Grande, Jason Christie, Bill Springer and Kristine O'Kane.

3.3 Development and Evaluation of Feasible Alternatives

3.3.1 Moffett Boulevard Alternatives Description and Feasibility Assessment

What follows is a description of each alternative and its particular feasible assessment summary. To obtain the rankings and ratings for the feasibility assessment of all alternatives, refer to **Table 1, Feasibility Alternatives Matrix for Moffett Boulevard**. For all alternatives described, a proposed low-flow channel is planned to be incorporated from the downstream portion of each alternative downstream to Highway 101.

Alternative No. 1 – Low Flow Channel Option (retain existing fish ladder structure, create a natural ramp instream and immediately adjacent to the west bank, and create low-flow channel downstream of fish ladder)

Description

This option is to retain the existing fish ladder. However, there would be two other components associated with this option.

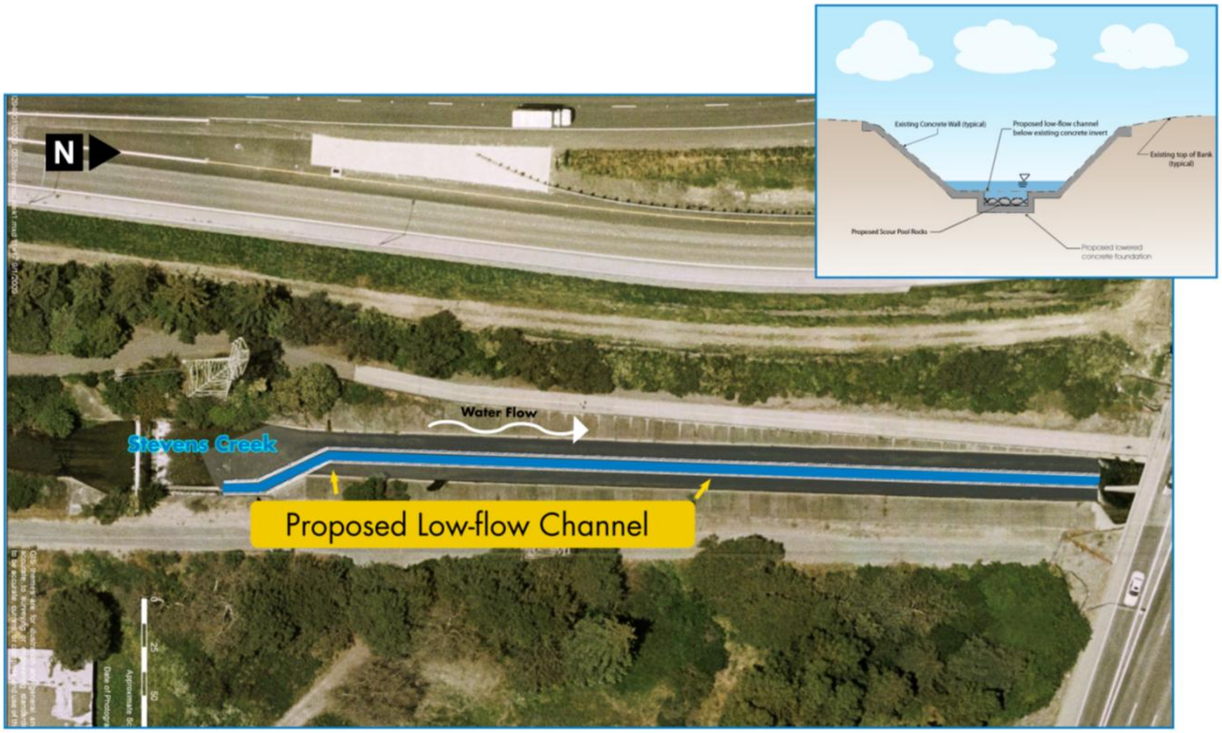
First, to address passage for other wildlife species (besides steelhead), a focused natural ramp would be incorporated instream, on top of the existing concrete channel bottom, and immediately adjacent to the west bank. This natural ramp would be wider at the concrete bottom, possibly taking about a quarter of the width of the concrete channel bottom and then sloping upwards to about a fifth of the width of the top of the drop structure. The slope of the natural ramp should be gradual, to allow for convenient access of other wildlife species. Therefore, the downstream limit of this natural ramp would be further than the existing downstream limit of the existing concrete drop. The natural ramp would be designed to not impact the overall function of the concrete drop, as well as, to minimize any local flooding impacts to the facility. Further details of the natural ramp will be evaluated during the design phase.

Second, a low-flow channel will be incorporated from downstream of the existing fish attractant pool to below U.S. 101.

Feasibility Assessment

The Denil-structure is a partial barrier. However, for this section of Stevens Creek, low-flows are continuous and prevalent. Although not as adequate as having full side access to the fish ladder structure, using some type of long equipment from the top of bank, while standing at the side railing, would be adequate for dislodging debris in the fish ladder during mid-to-high flows. During seasonal low-flows, a vacuum truck or manual labor can be used to remove sediment and debris from the fish ladder and the fish attractant pool. At this location, low-flows are normally present. Therefore, fish stranding is not likely an issue. With this alternative, there is no geomorphic enhancement of the facility, nor impacts to existing vegetation or the existing trail. Adding the natural ramp may have a very minor local affect on the flood capacity. The proposed low-flow channel would provide continuous access from U.S. 101 to Moffett Boulevard. Further details on the natural ramp will be described during the design phase.

Figures 16 and 17 show the pertinent views for the proposed low-flow channel. These views would apply to all options for this facility.


N
Water Flow
Stevens Creek
Proposed Low-flow Channel
Existing Concrete Wall (typical)
Proposed low-flow channel below existing concrete invert
Existing top of Bank (typical)
Proposed Scour Pool Rocks
Proposed lowered concrete foundation

Figures 16 & 17. Moffett Boulevard Drop Structure (All alternatives)

Alternative No. 2 – Scour Pool and Weir Option (plus, create low-flow channel downstream of fish ladder)

Description

This alternative proposes to remove the existing Denil structure, its associated fish attractant pool, and create a series of scour pools and weirs, composed of natural rocks, and rock riprap to simulate a natural pool and weir system. The jump heights from weir to weir would be set at maximum half-foot drops. Upon removal of the existing drop structure, to accommodate the natural scour pool and weir system, the existing lateral integrity of the concrete trapezoidal structure would be structurally impacted. To maintain structural integrity between the walls, a lowered concrete foundation will be constructed to maintain connection between the existing trapezoidal walls. The scour pool and weir system will be designed and placed above this lowered concrete foundation. Further details on the design of the lowered concrete foundation will be addressed during the design phase. The proposed weirs for this new system would most likely be grouted to the lowered concrete foundation to maintain stability and integrity of the whole system.

The most downstream pool/weir will terminate and conform to a new proposed low-flow channel that extends to U.S. 101. Refer to Figures 16 and 17 for a view of the proposed low-flow channel.

Figure 18 shows the plan view of this alternative.

Figure 19 shows the pertinent profile of the scour pool and weir system.

Figures 20 and 21 show the pertinent sections.

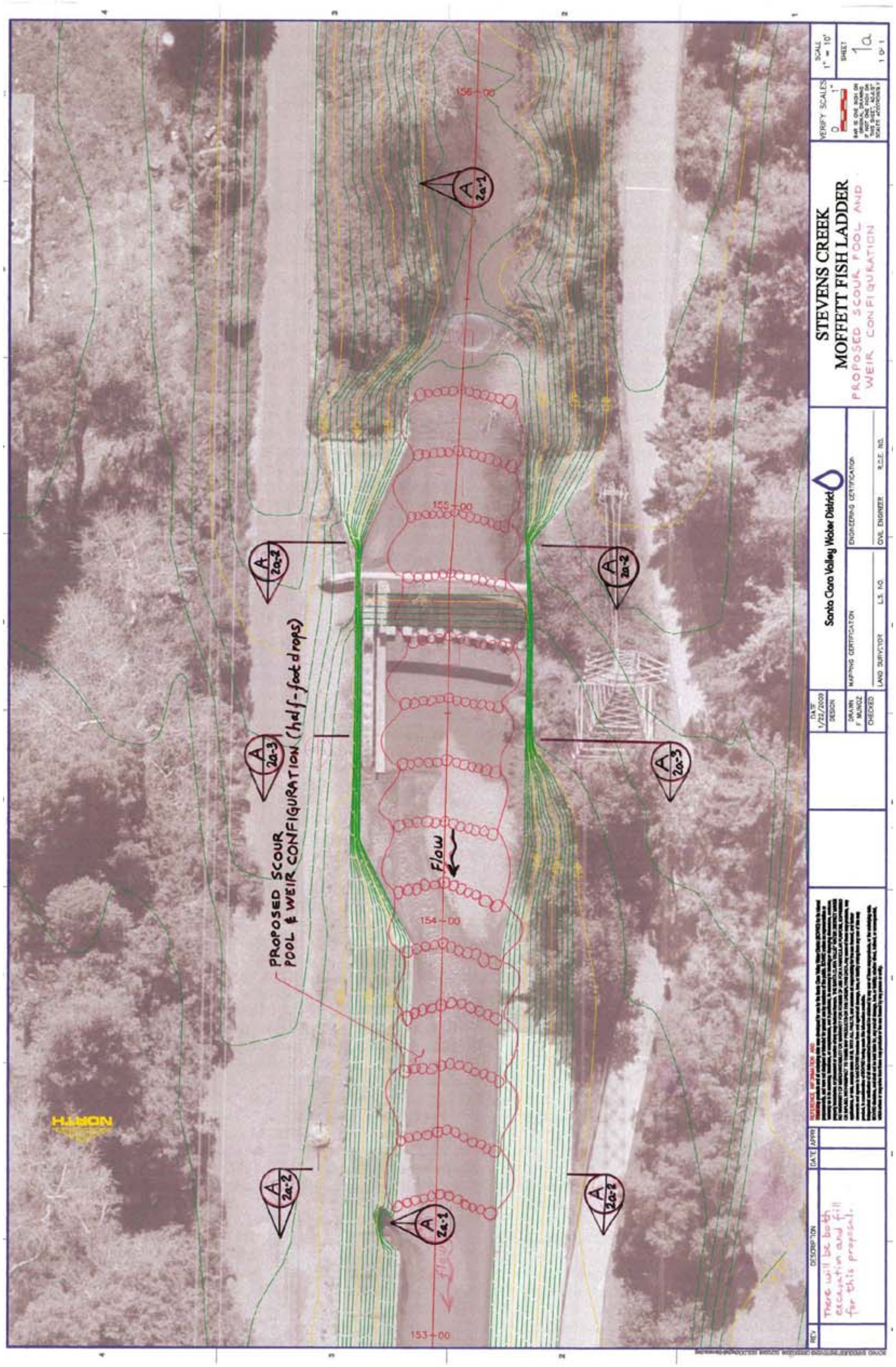

STEVENS CREEK
MOFFETT FISH LADDER
PROPOSED SCOUR POOL AND WEIR CONFIGURATION
Santa Clara Valley Water District
SCALE 1" = 10'
SHEET 1a
1 OF 1
VERIFY SCALES
DATE 1/22/2009
DRAWN F MUNOZ
PROPOSED SCOUR POOL & WEIR CONFIGURATION (half-foot drops)
Flow
156+00
155+00
154+00
153+00
A 2a-1
A 2a-2
A 2a-3
NORTH
REV
DESCRIPTION
DATE
APPR
There will be both excavation and fill for this proposal.

Figure 18. Moffett Boulevard Drop Structure (Fish Ladder Alternative No. 2)

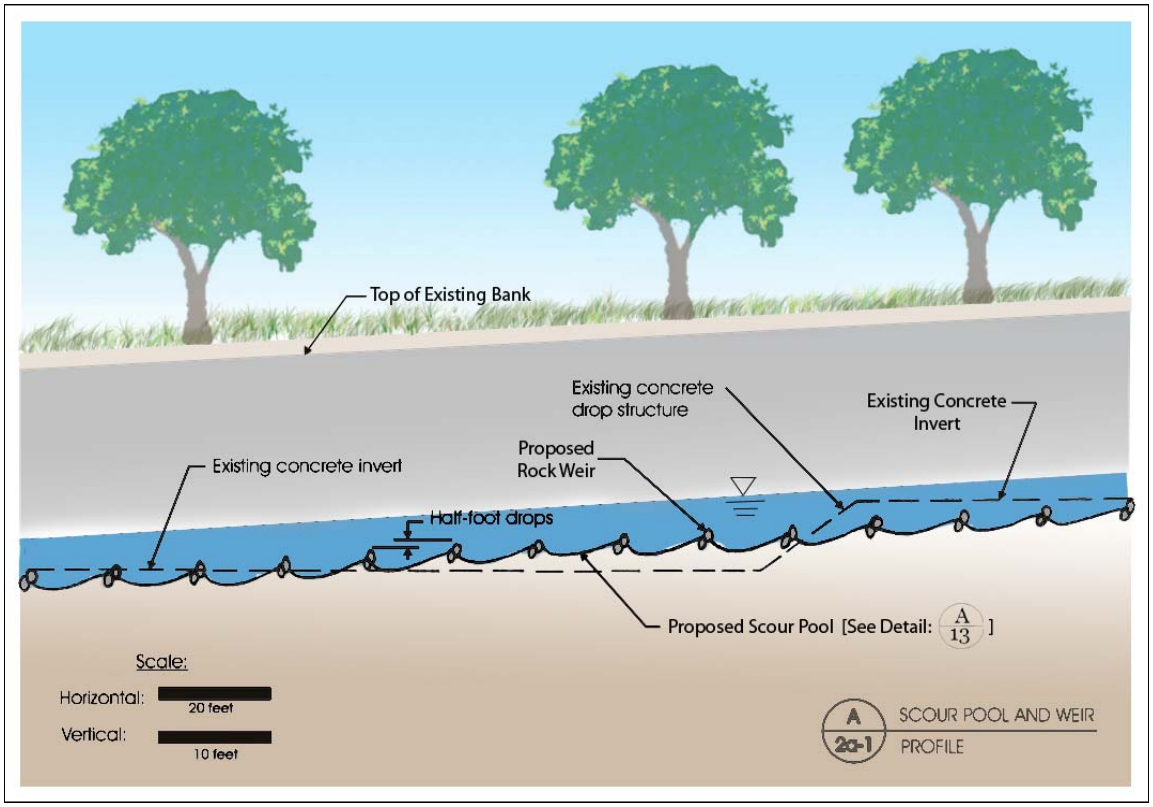
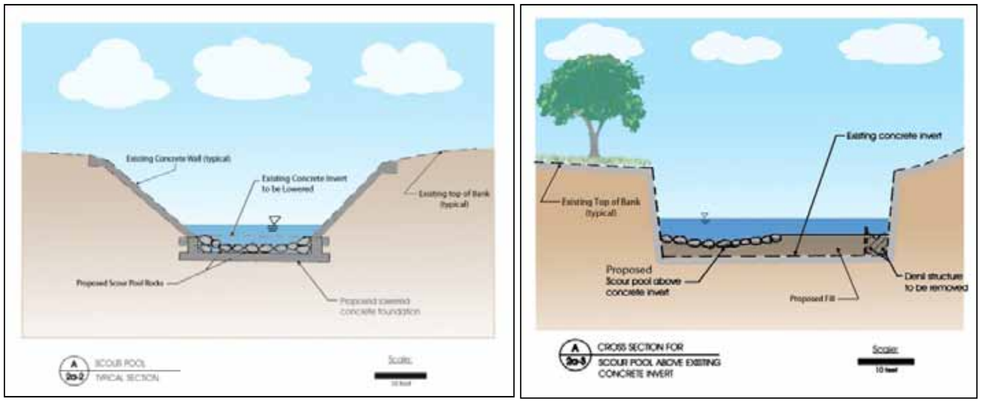


Figure 19. Moffett Boulevard Drop Structure (Fish Ladder Alternative No. 2)


Existing Concrete Wall (typical)
Existing Concrete Invert to be Lowered
Existing top of Bank (typical)
Proposed Scour Pool Rocks
Proposed lowered concrete foundation
A
2a-2
SCOUR POOL
TYPICAL SECTION
Scale:
10 feet
Existing concrete invert
Existing Top of Bank (typical)
Proposed Scour pool above concrete invert
Proposed Fill
Denil structure to be removed
A
2a-3
CROSS SECTION FOR
SCOUR POOL ABOVE EXISTING CONCRETE INVERT
Scale:
10 feet

Figures 20 & 21. Moffett Boulevard Drop Structure (Fish Ladder Alternative No. 2)

Feasibility Assessment

With this alternative, the expected operations and maintenance frequency would probably occur once per year. Migrating fish would not likely be stranded, nor wildlife species be impeded in their migration, since the natural slopes are very mild and low-flows could be accommodated through the natural rock system. The encroachment of the mild natural rock structure could have a minor local negative impact on flood capacity. Since the existing surroundings of the structure are already mostly concrete, there would be no direct impact to erosion prevention or inducement. The most challenging aspect of this alternative is construction of the natural rock pool and weir system within the existing concrete structure. There will be temporal impacts to existing concrete walls and bottom, requiring extensive shoring. This concept is new and historically untested. Therefore, the estimated frequency of operations and maintenance for this alternative may increase. Additional study relating to sediment transport and even physical modeling of the hydraulics, during the design phase, may improve confidence on the outcome. This alternative should conform naturally with the existing channel. The proposed low-flow channel would provide continuous access from U.S. 101 to Moffett Boulevard.

Alternative No. 3 – Concrete Pool and Weir Option (plus, create low-flow channel downstream of fish ladder and create a focused natural ramp instream and immediately adjacent to the west bank)

Description

This alternative proposes to remove the existing Denil structure, its associated fish attractant pool, and create a series of concrete pools and weirs where the existing Denil structure is currently situated. The jump heights from weir to weir would be set at maximum half-foot drops. Ninety percent of the low-flows during the migration period from September 15 to May 31 results in less than 1 cubic feet per second (cfs) flow. The pools will be designed to accommodate at least a flow of 1 cfs.

The concrete pools and weirs will continue downstream beyond the limit of the Denil structure and impact the easterly existing sloped section of the concrete trapezoidal channel. A vertical retaining wall will have to be constructed to accommodate the concrete pools and weirs. The plan view shows a low-flow section beyond the fish attractant pool. The proposed low-flow channel would provide continuous access from U.S. 101 to Moffett Boulevard. Refer to Figures 16 and 17 for a view of the proposed low-flow channel. Further details on the natural ramp will be described during the design phase.

Figure 22 shows the plan view of this alternative.

Figure 23 shows the pertinent profile of the concrete pool and weir system.

Figure 24 shows the pertinent section.

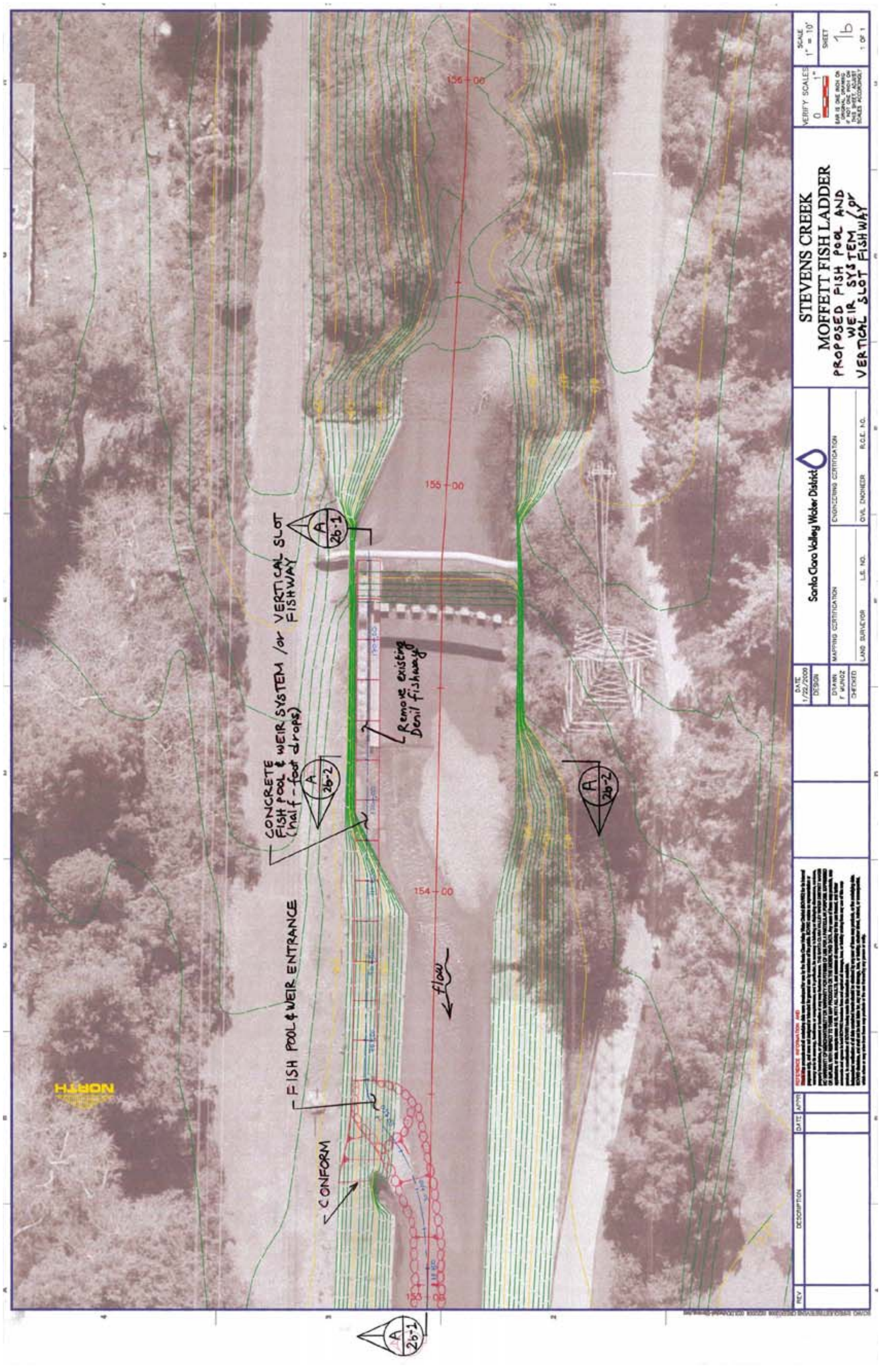

STEVENS CREEK
MOFFETT FISH LADDER
PROPOSED FISH POOL AND WEIR SYSTEM /or VERTICAL SLOT FISHWAY
Santa Clara Valley Water District
CONCRETE FISH POOL & WEIR SYSTEM /or VERTICAL SLOT FISHWAY (half-foot drops)
FISH POOL & WEIR ENTRANCE
CONFORM
Remove existing Denil fishway
flow
NORTH
156+00
155+00
154+00
153+00
A 26-1
A 26-2
SCALE 1" = 10'
VERIFY SCALES
SHEET 1b
1 OF 1

Figure 22. Moffett Boulevard Drop Structure (Fish Ladder Alternative No. 3 or 4)

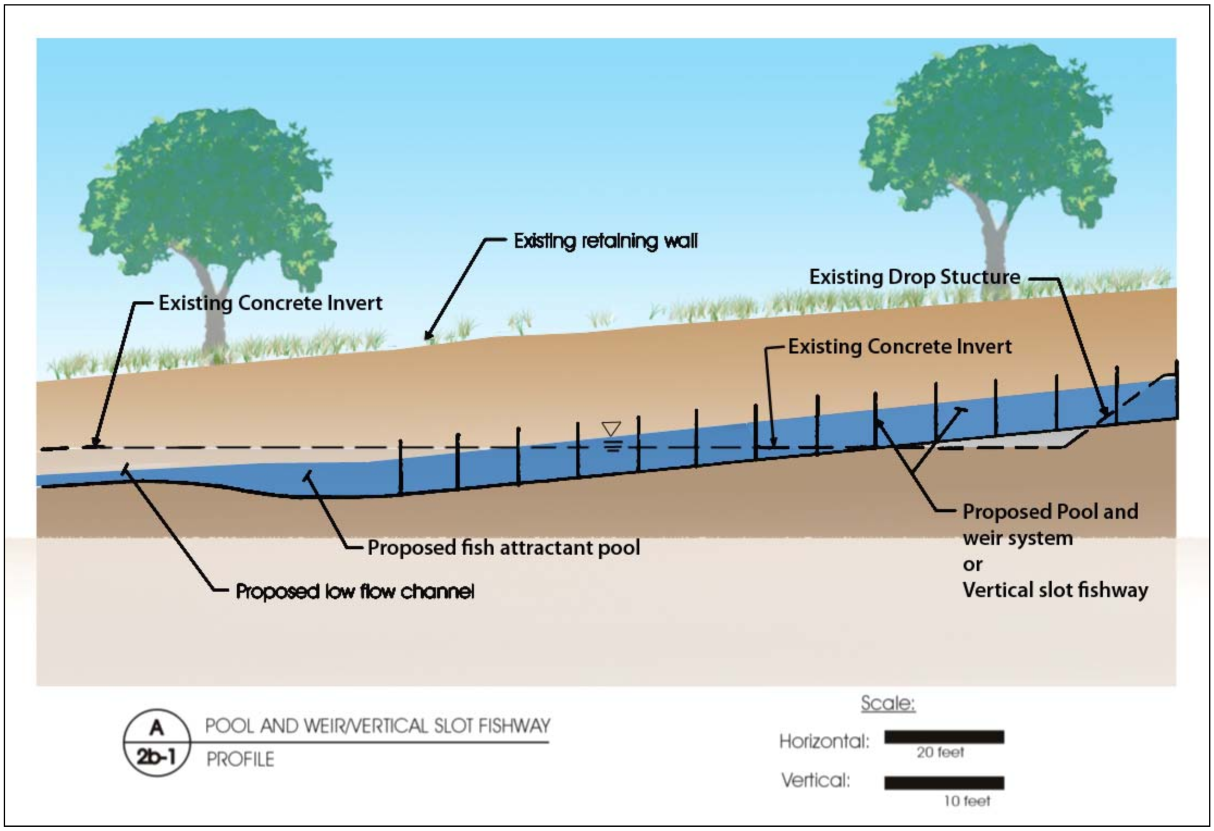


Figure 23. Moffett Boulevard Drop Structure (Fish Ladder Alternative No. 3 or 4)

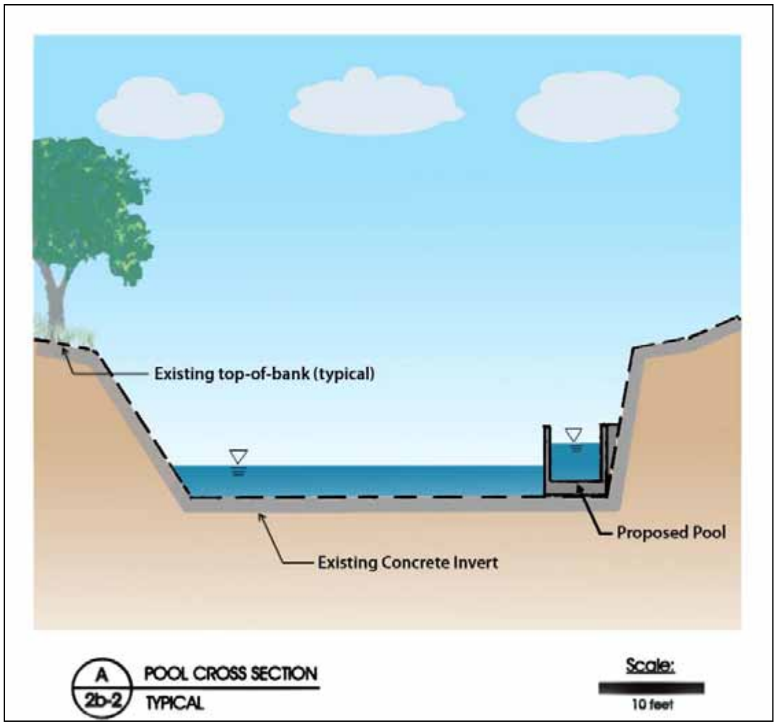


Figure 24. Moffett Drop Structure (Fish Ladder Alternative No. 3 or 4)

Feasibility Assessment

With this alternative, the expected operations and maintenance frequency would probably occur once per year. Migrating fish would likely be stranded if there are very low-flows coming through the system. The proposed concrete structure should have no or slight impact on flood capacity, since it is within the same location of the existing Denil structure. Since the existing surroundings of the structure are already mostly concrete, there really would be no direct impact to erosion prevention or inducement. The most challenging aspect of this alternative would be modification of the eastern concrete wall. However, compared with the construction of the scour pool and weir system, the amount of materials to be removed and placed would be significantly less. Historically, this concept has been used in several locations, including the concrete pool-and-weir fish ladder in Guadalupe River, adjacent to the District Headquarters. Therefore, the estimated frequency of operations and maintenance for this alternative should not change. This concrete alternative should conform to the existing concrete channel configuration. Adding the natural ramp may have a very minor local affect on the flood capacity. The proposed low-flow channel would provide continuous access from U.S. 101 to Moffett Boulevard.

Alternative No. 4 –Vertical Slot Fishway Option (plus, create low-flow channel downstream of fish ladder and create a focused natural ramp instream and immediately adjacent to the west bank)

Description

This alternative proposes to remove the existing Denil structure, its associated fish attractant pool, and create a vertical slot fishway where the existing Denil structure is currently situated. The jump heights from weir to weir would be set at maximum half-foot drops. Ninety percent of the low-flows during the migration period from September 15 to May 31 results in less than 1 cubic feet per second (cfs) flow. The pools will be designed to accommodate at least a flow of 1 cfs.

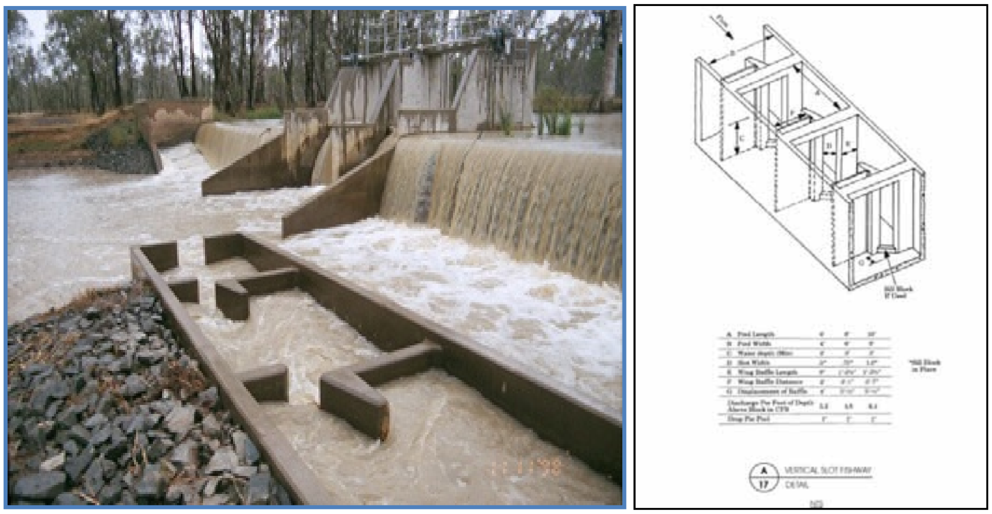
The vertical slot fishway will continue downstream beyond the limit of the Denil structure and impact the easterly existing sloped section of the concrete trapezoidal channel. A vertical retaining wall will have to be constructed to accommodate the concrete pools and weirs. The plan view shows a low-flow section beyond the fish attractant pool. The proposed low-flow channel would provide continuous access from U.S. 101 to Moffett Boulevard. Refer to Figures 16 and 17 for a view of the proposed low-flow channel. Further details on the natural ramp will be described during the design phase.

Refer to Figure 22 for a plan view of this alternative.

Refer to Figure 23 for the pertinent profile of the vertical slot fishway system.

Refer to Figure 24 for the pertinent section.

Figures 25 and 26 show a sample view and schematic detail of the vertical slot fishway.



Figures 25 & 26. Moffett Boulevard Drop Structure (Fish Ladder Alternative No. 4)

Feasibility Assessment

With this alternative, the expected operations and maintenance frequency would probably occur once per year, to ensure the full vertical slot openings of the fishway are functioning. Migrating fish would not likely be stranded even if there are very low-flows coming through the system; the full open vertical slot and the straight bottom slope of the fishway should allow most flows to pass through and not cause stranding of fish. The proposed concrete structure would have no or slight impact on flood capacity, since it is within the same location of the existing Denil structure. Since the existing surroundings of the structure are already mostly concrete, there really would be no direct impact to erosion prevention or inducement. The most challenging aspect of this alternative would be modification of the eastern concrete wall. However, compared with the construction of the scour pool and weir system, the amount of materials to be removed and placed would be significantly less. Historically, this concept has been used in some locations (including Niles Dam, St. Joseph River, Berrien County, MI), but has not been extensively used compared with concrete pool and weir structures. Still, the estimated frequency of operations and maintenance for this alternative should not likely change. This concrete alternative should conform to the existing concrete channel configuration. Adding the natural ramp may have a very minor local affect on the flood capacity. The proposed low-flow channel would provide continuous access from U.S. 101 to Moffett Boulevard.

Table 1 - Feasibility Alternatives Matrix for Moffett Boulevard

Moffett Boulevard Issues and Concerns	Alternative No. 1 Low Flow Channel Option	Alternative No. 2 Scour Pool & Weir Option	Alternative No. 3 Concrete Pool & Weir Option	Alternative No. 4 Vertical Slot Fishway Option
1. Project Cost	Construction: $ 1.00 mil 30-Yr Maint: $ 0.54 mil Total: $ 1.54 mil Rating = 7	Construction: $ 2.30 mil 30-yr Maint: $ 0.54 mil Total: $ 2.84 mil Rating = 5	Construction: $ 1.93 mil 30-yr Maint: $ 0.63 mil Total: $ 2.56 mil Rating = 5	Construction: $ 1.93 mil 30-yr Maint: $ 0.63 mil Total: $ 2.56 mil Rating = 5
2. Maintainability and Operability	Annual maint frequency: 1x Can fish likely be stranded during extreme low-flows? Not likely Rating = 10	Annual maint frequency: 1x Can fish likely be stranded during extreme low-flows? Not likely Rating = 10	Annual maint frequency: 1x Can fish likely be stranded during extreme low-flows? Not likely Rating = 10	Annual maint frequency: 1x Can fish likely be stranded during extreme low-flows? Not likely Rating = 10
3. Passage for other Wildlife Species	Allows full adequate passage when mitigated Rating = 8	Allows full adequate passage Rating = 10	Allows full adequate passage when mitigated Rating = 9	Allows full adequate passage when mitigated Rating = 7
4. Flood Capacity Impact	No impact. Rating = 10	No impact. Rating = 10	Moderate negative impact. Rating = 6	No impact. Rating = 10
5. Geomorphic Enhancement	None Rating = 5	None Rating = 5	None. Rating = 5	None. Rating = 5
6. Community Impacts	No impacts to vegetation or trail. Rating = 10	No long term impacts to vegetation or trail. Rating = 9	No long term impacts to vegetation or trail. Rating = 9	No long term impacts to vegetation or trail. Rating = 9
7. Constructability	The existing will have a minor modification. There should be very minor impacts to existing structure. Rating = 9	Temporal impacts to both concrete walls and bottom. Requires extensive shoring. More cut and fill. Rating = 5	Temporal impacts to east wall. Requires shoring. Rating = 6	Temporal impacts to east wall. Requires shoring. Rating = 6
8. Potential Lifespan of Facility	There is flow going thru Denil structure most times. Rating = 8	Concept is somewhat new and historically untested. Rating = 7	Has been used for many years. Rating = 10	Use of concept less than pool and weir. Rating = 8
9. Aesthetics	Existing Denil considered an eye sore element. Rating = 5	Very favorable natural alternative. Rating = 10	Less favorable structure (concrete), but can be mitigated. Rating = 7	Less favorable structure (concrete), but can be mitigated. Rating = 6
TOTAL RATING SCORE:	**72**	**71**	**67**	**66**

3.3.2 Evelyn Avenue Alternatives Description and Feasibility Assessment

What follows is a description of each alternative and its particular feasible assessment summary. To obtain the rankings and ratings for the feasibility assessment of all alternatives, refer to **Table 2, Feasibility Alternatives Matrix for Evelyn Avenue**.

Alternative No. 1 – No Project Option

Description

This alternative does not include any improvements to the facility. It maintains the existing condition of the facility.

Feasibility Assessment

With this alternative, there is no impact to flood capacity; no geomorphic enhancement of the facility; nor impacts to existing vegetation or the existing trail. However, without improvements to the existing facility, partial barriers to passage of fish and other aquatic species will exist, especially during low-flow periods. The location of the existing Denil structure itself is not located appropriately to capture low-flows. The structure and hard-armored stream bed in a confined and incised channel will continue to experience blockage, which can significantly impede fish migration. The existing facility does not allow maintenance crews or operations staff adequate access to remove this blockage during intermediate to high flows. The box culvert will continue to be the primary trajectory for low-flows. The existing obsolete gauging weir will continue to be a partial barrier.

Alternative No. 2 – Scour Pool and Weir Option

Description

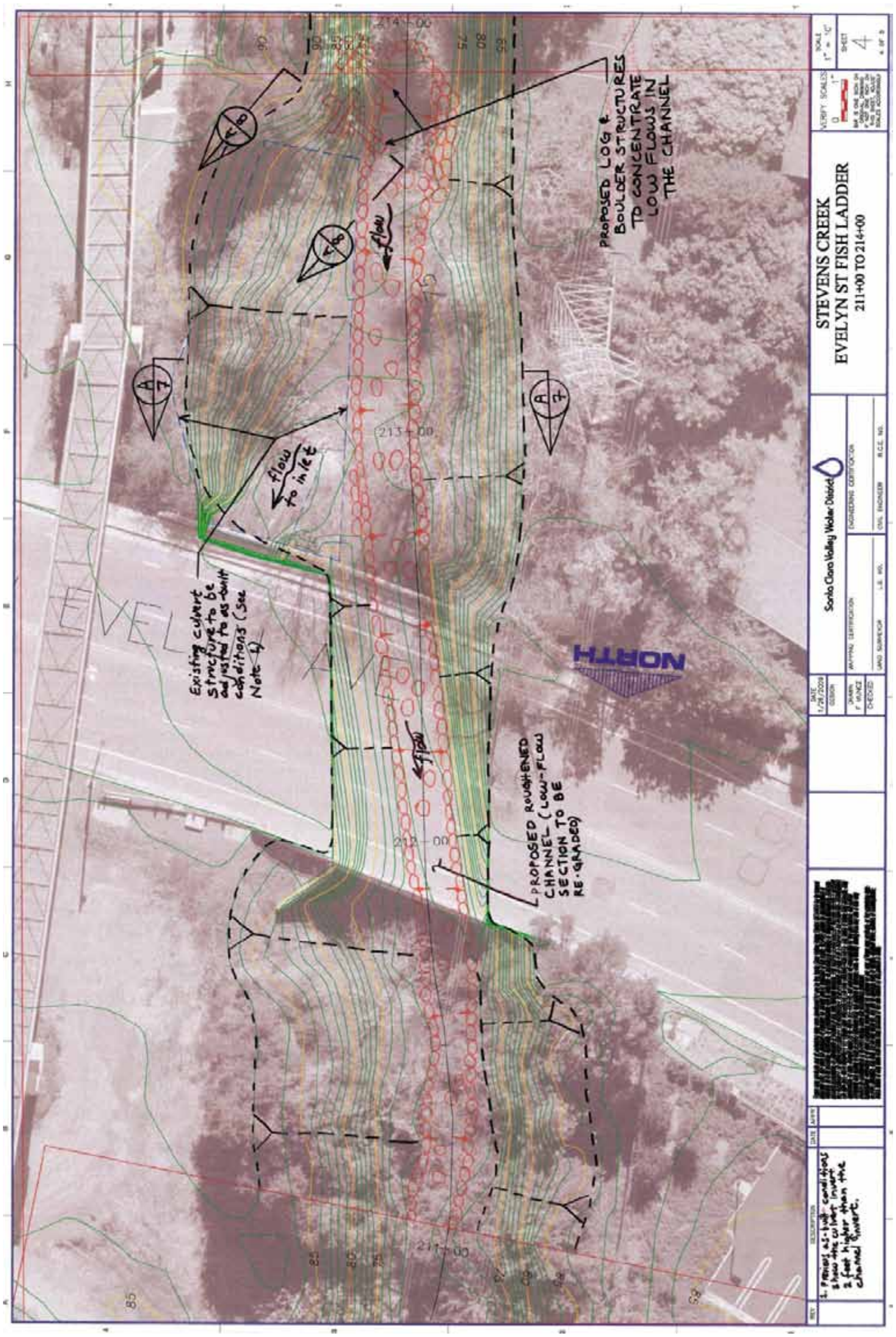
This alternative proposes to remove the existing Denil structure and create a series of scour pools and weirs, composed of natural rocks, and rock riprap to simulate a natural pool and weir system. The associated Denil fish attractant pool, along with the concretized rock-like rubbles, will also be removed. The jump heights from weir to weir would be set at maximum half-foot drops.

Since major structural impacts to the foundation of the arched Union Pacific Railroad bridge (UPRR) and the VTA Light Rail crossing would likely not be permitted, the scour pool and weir system will be constructed from downstream of the bridge and conform to confluence at downstream of the existing box culvert. The existing box culvert is a high-flow channel which is located easterly and parallel to the main channel. It is also located beneath Evelyn Avenue, UPRR, a Caltrain bridge, and Central Expressway. Underneath the UPRR Bridge, a low-flow section with natural rocks will be created. The width of this low-flow section will be restricted by two low-level retaining walls, which will be doweled to the upper foundation of the arched bridge. Upstream of the bridge, a low-flow narrow roughened channel section will be created, up to and conform to upstream of the existing box culvert. The obsolete gauging weir will also be removed. The low-flow roughed section next to the invert entrance of the box culvert will be configured, allowing the previous as-built condition of the concrete invert to emerge, with at least two feet higher invert elevation than the low-flow roughened section. Two stream log and boulder structures will be constructed just upstream of the box culvert entrance, at the lower portion of the east bank. The function of these structures will be to concentrate and maintain the low-flows in the main channel. Additional rocks opposite the lower portion of the west bank may be required to prevent erosion potential on the west bank.

Figures 27 and 28 show the plan views of this alternative.

Figure 29 shows the pertinent profile of the scour pool and weir system.

Figures 30 to 34 show the pertinent sections.


STEVENS CREEK
EVELYN ST FISH LADDER
211+00 TO 214+00
Santa Clara Valley Water District
PROPOSED LOG & BOULDER STRUCTURES TO CONCENTRATE LOW FLOWS IN THE CHANNEL
flow
flow to inlet
Existing culvert structure to be adjusted to as-built conditions (See Note 1)
PROPOSED ROUGHENED CHANNEL (LOW-FLOW SECTION TO BE RE-GRADED)
NORTH
214+00
213+00
212+00
211+00
A 7
B 7
1. Revise as-built conditions show the culvert invert 2 feet higher than the channel invert.

[redacted]

Figure 27. Evelyn Avenue Drop Structure (Fish Ladder Alternative No. 2)

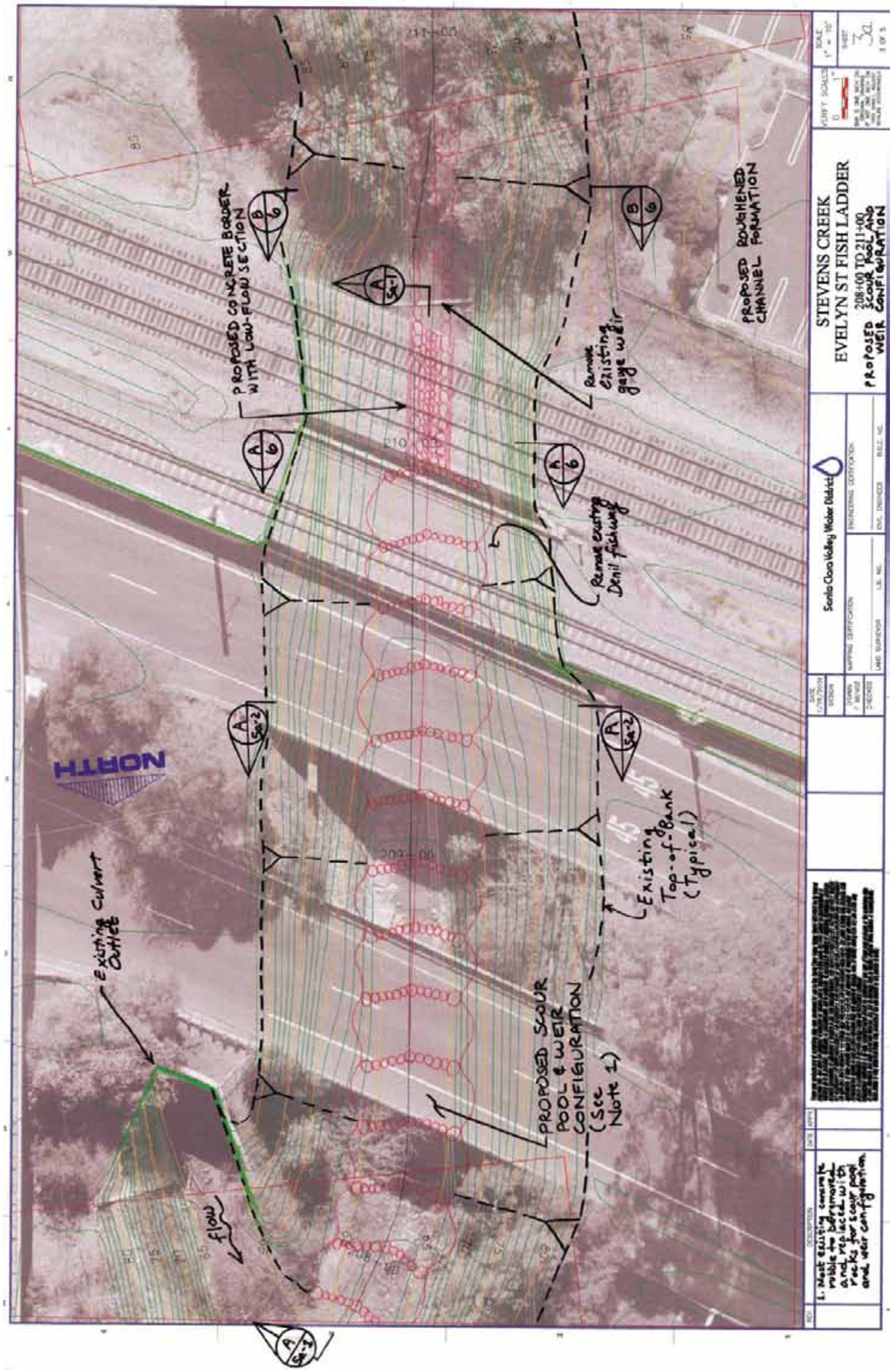

STEVENS CREEK
EVELYN ST FISH LADDER
208+00 TO 211+00
PROPOSED SCOUR POOL AND WEIR CONFIGURATION
Santa Clara Valley Water District
SCALE 1" = 10'
3a
PROPOSED CONCRETE BORDER WITH LOW-FLOW SECTION
PROPOSED ROUGHENED CHANNEL FORMATION
Remove existing gage weir
Remove existing Denil fishway
Existing Top-of-Bank (Typical)
PROPOSED SCOUR POOL & WEIR CONFIGURATION (See Note 1)
Existing Culvert Outlet
flow
NORTH
211+00
210+00
209+00
1. Most existing concrete rubble to be removed and replaced with rocks for scour pool and weir configuration.

Figure 28. Evelyn Avenue Drop Structure (Fish Ladder Alternative No. 2)

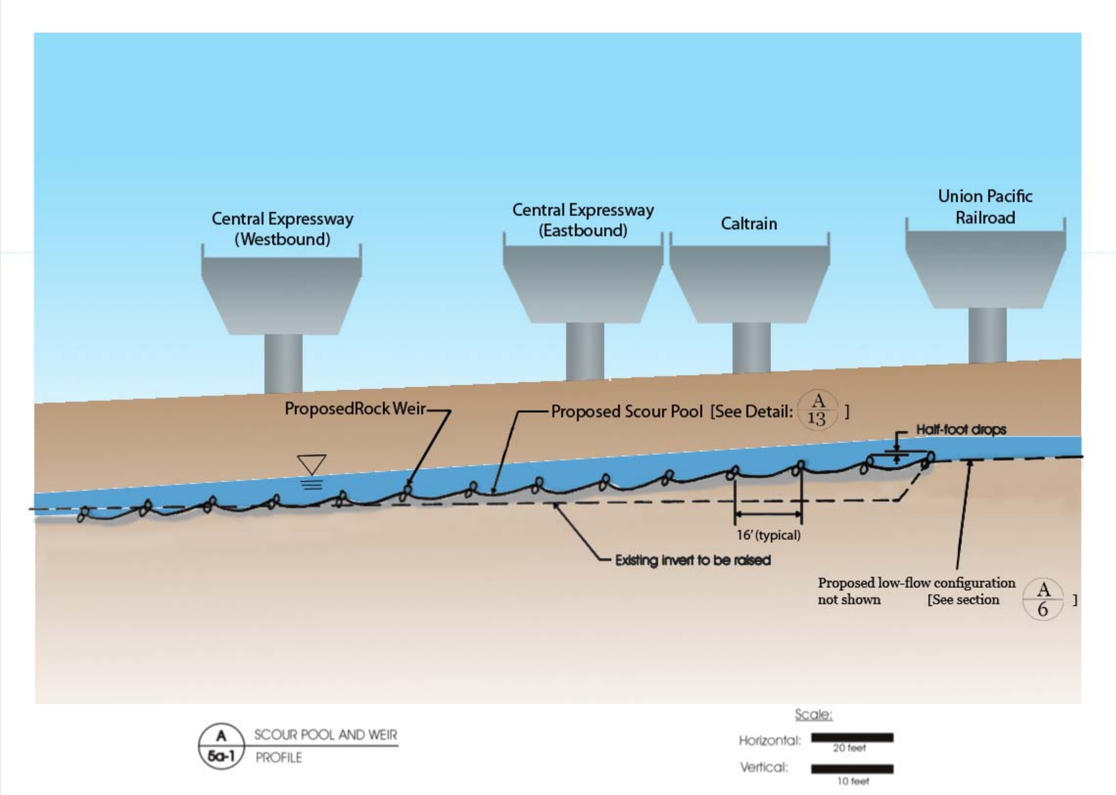


Figure 29. Evelyn Avenue Drop Structure (Fish Ladder Alternative No. 2)

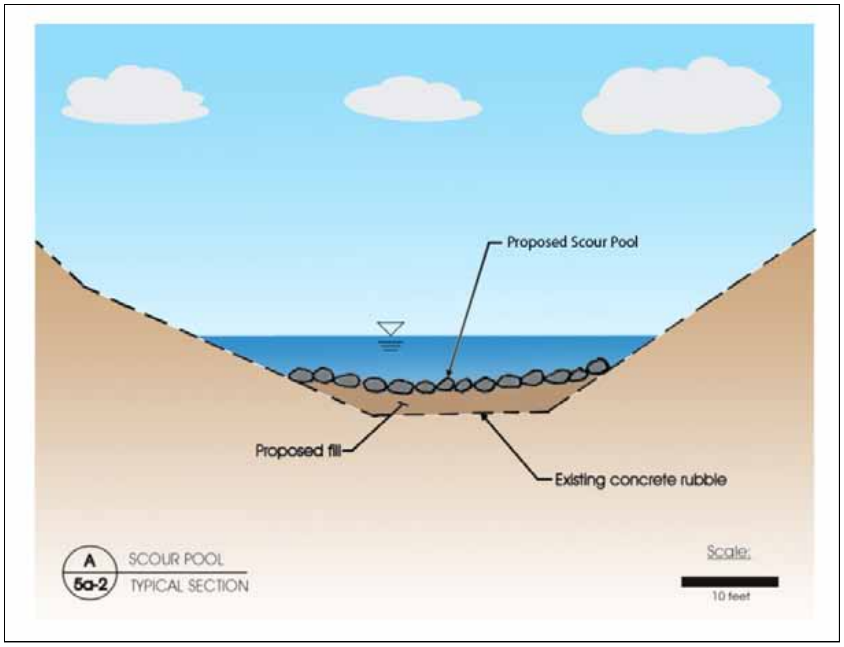


Figure 30. Evelyn Avenue Drop Structure (Fish Ladder Alternative No. 2)

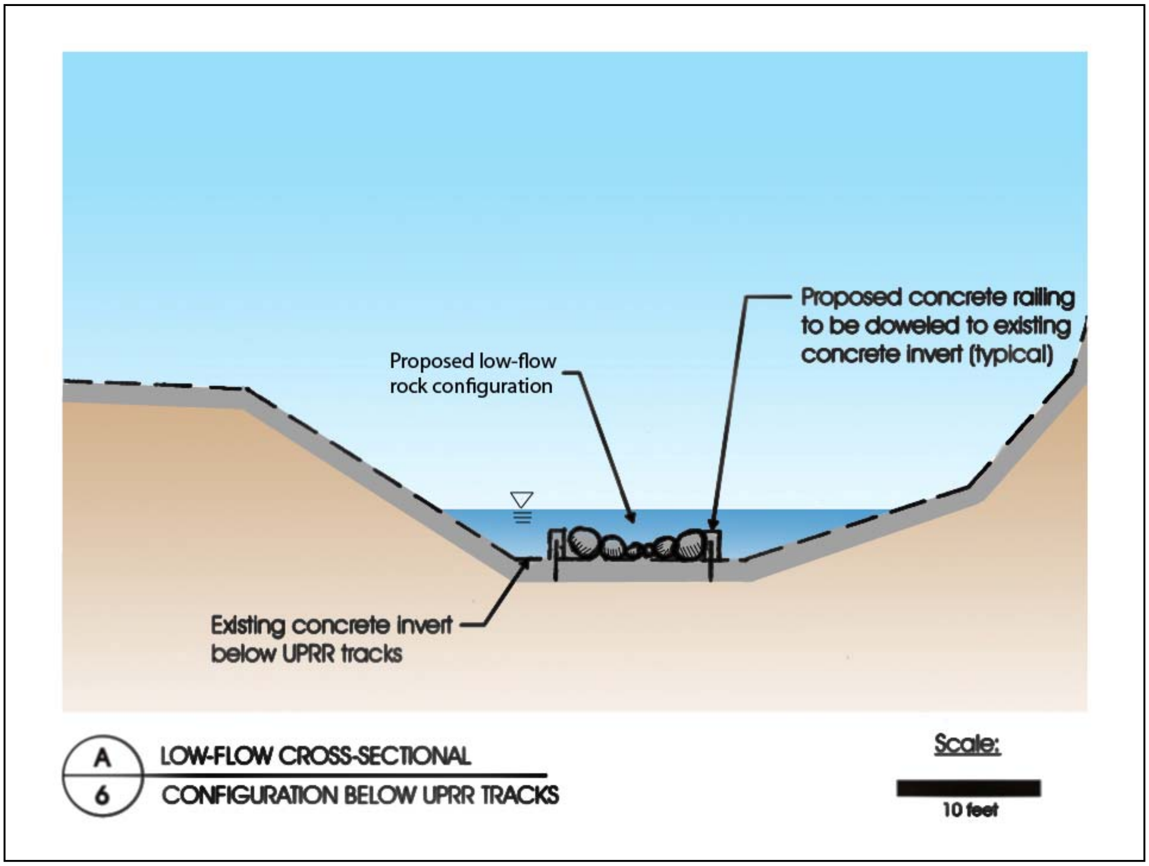

Proposed concrete railing to be doweled to existing concrete invert (typical)
Proposed low-flow rock configuration
Existing concrete invert below UPRR tracks
A
6
LOW-FLOW CROSS-SECTIONAL CONFIGURATION BELOW UPRR TRACKS
Scale:
10 feet

Figure 31. Evelyn Avenue Drop Structure (Fish Ladder Alternative Nos. 2, 3, 4)

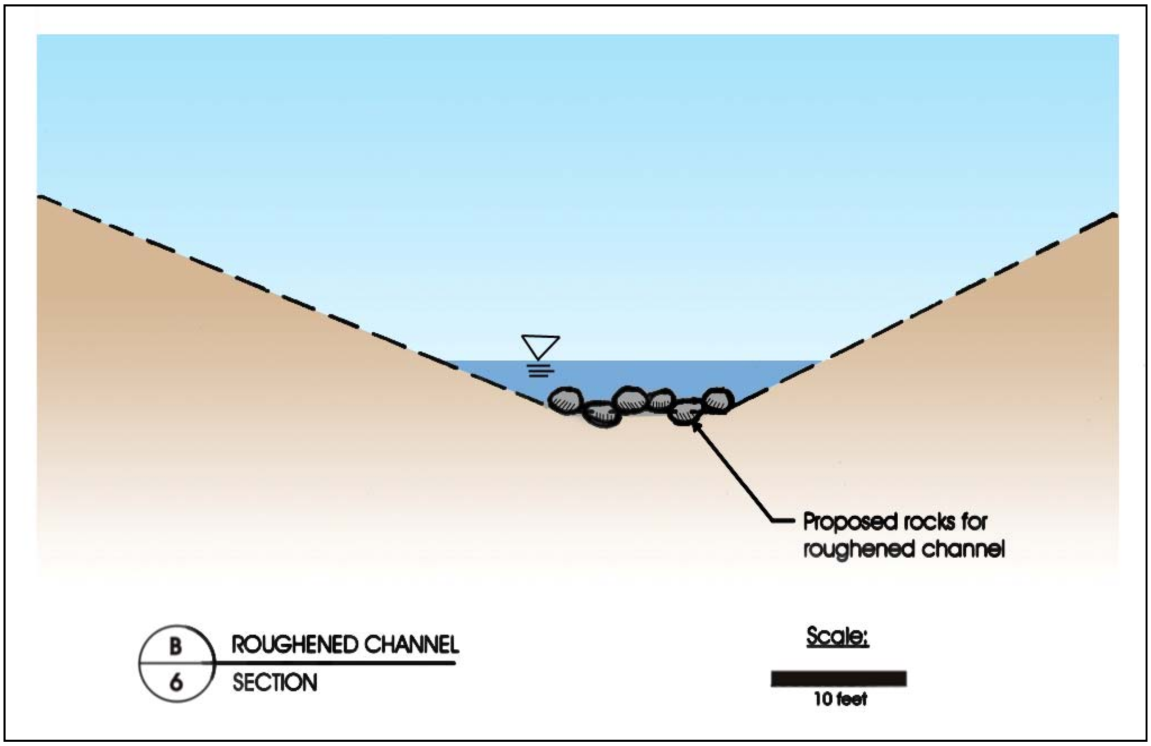

Proposed rocks for roughened channel
B
6
ROUGHENED CHANNEL SECTION
Scale:
10 feet

Figure 32. Evelyn Avenue Drop Structure (Fish Ladder Alternative Nos. 2, 3, 4)

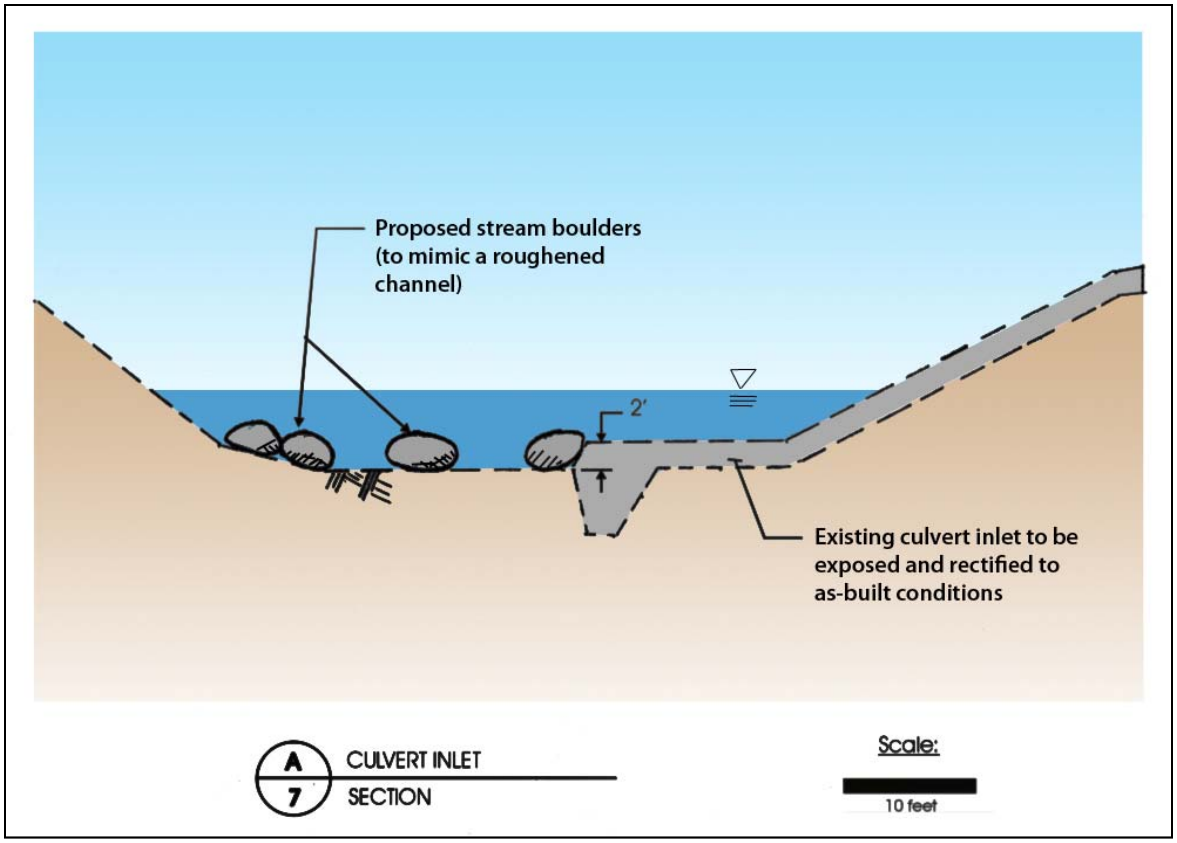

Proposed stream boulders (to mimic a roughened channel)
2'
Existing culvert inlet to be exposed and rectified to as-built conditions
A
7
CULVERT INLET
SECTION
Scale:
10 feet

Figure 33. Evelyn Avenue Drop Structure (Fish Ladder Alternative Nos. 2, 3, 4)

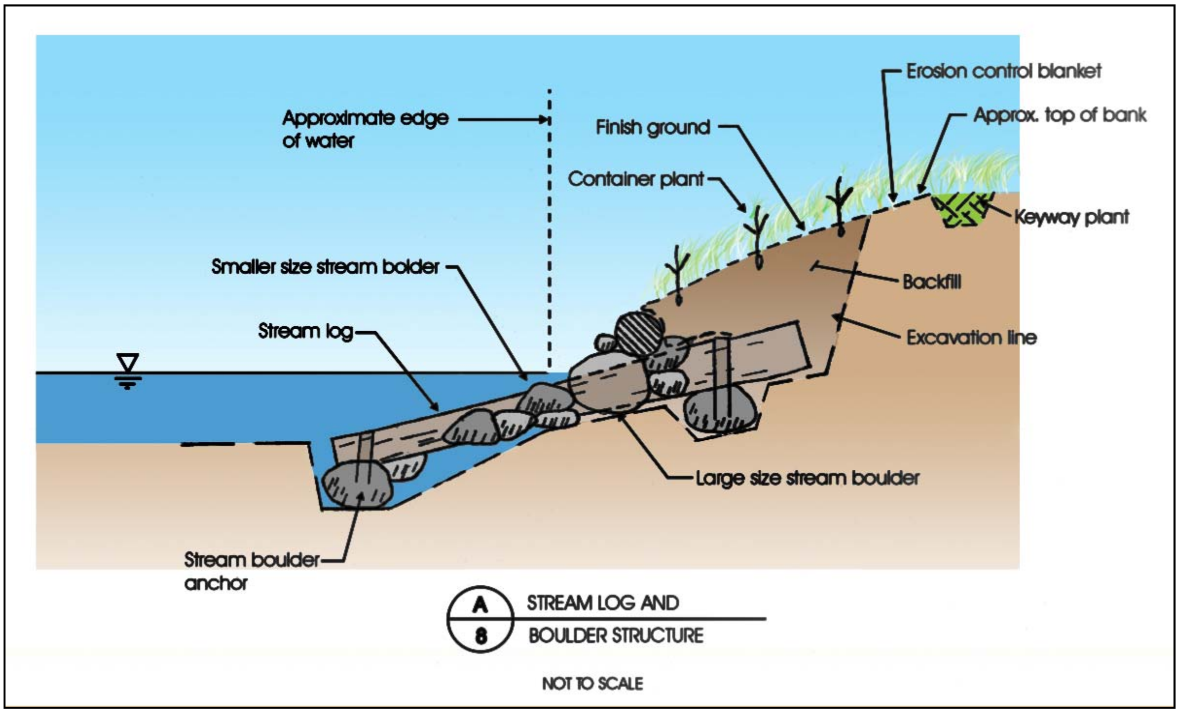


Figure 34. Evelyn Avenue Drop Structure (Fish Ladder Alternative Nos. 2, 3, 4)

Feasibility Assessment

With this alternative, the expected operations and maintenance frequency would probably occur once per year. Migrating fish would not likely be stranded, nor wildlife species be impeded in their migration, throughout the life of the structure, since the natural slopes are very mild and low-flows could be accommodated through the natural rock system. The encroachment of the mild natural rock structure could have a minor local negative impact on flood capacity. Since the existing surroundings of the structure are already mostly concrete, there would be no direct impact to erosion prevention or inducement. There may be minor impacts to existing vegetation due to the construction of the stream log and boulder structures, but this could probably be mitigated for. The most challenging aspect of this alternative is construction access. Since this alternative requires removal of the existing fish ladder structure and concrete rubbles, besides import of a sizable number of rocks, construction of this alternative would be difficult. This concept is new and historically untested. Additional study relating to sediment transport and even physical modeling of the hydraulics during the design phase may improve confidence in the outcome. Therefore, the estimated frequency of operations and maintenance for this alternative may increase. This alternative should conform naturally with the existing channel.

Alternative No. 3 – Concrete Pool and Weir Option

Description

This alternative proposes to remove the existing Denil structure and create a series of concrete pools and weirs downstream of the arched Union Pacific Railroad crossing. The associated Denil fish attractant pool, along with the concretized rock-like rubbles, will also be removed. The jump heights from weir to weir would be set at maximum half-foot drops. Ninety percent of the low-flows during the migration period from September 15 to May 31 results in less than 1 cubic feet per second (cfs) flow. The pools will be designed to accommodate at least a flow of 1 cfs.

The concrete pools and weirs will terminate halfway between the arched bridge and the confluence point of the main channel and high-flow channel at downstream end of the existing box culvert. Therefore, immediately downstream of the fish attractant pool, a low-flow roughened channel section will be constructed and conform to downstream of the existing box culvert. Underneath the bridge, a low-flow section with natural rocks will be created. The width of this low-flow section will be restricted by two low-level retaining walls, which will be doweled to the upper foundation of the arched bridge. Upstream of the bridge, a low-flow narrow roughened channel section will be created, up to and conform to upstream of the existing box culvert. The obsolete gauging weir will also be removed. The low-flow roughed section next to the invert entrance of the box culvert will be configured, allowing the previous as-built condition of the concrete invert to emerge, with at least two feet higher invert elevation than the low-flow roughened section. Two stream log and boulder structures will be constructed just upstream of the box culvert entrance, at the lower portion of the east bank. The function of these structures will be to concentrate and maintain the low-flows in the main channel. Additional rocks opposite the lower portion of the west bank may be required to prevent erosion potential on the west bank.

Refer to Figures 28 and 35 for the plan views of this alternative.

Figure 36 shows the pertinent profile of the concrete pool and weir system.

Figures 31 to 34, and 37 show the pertinent sections.

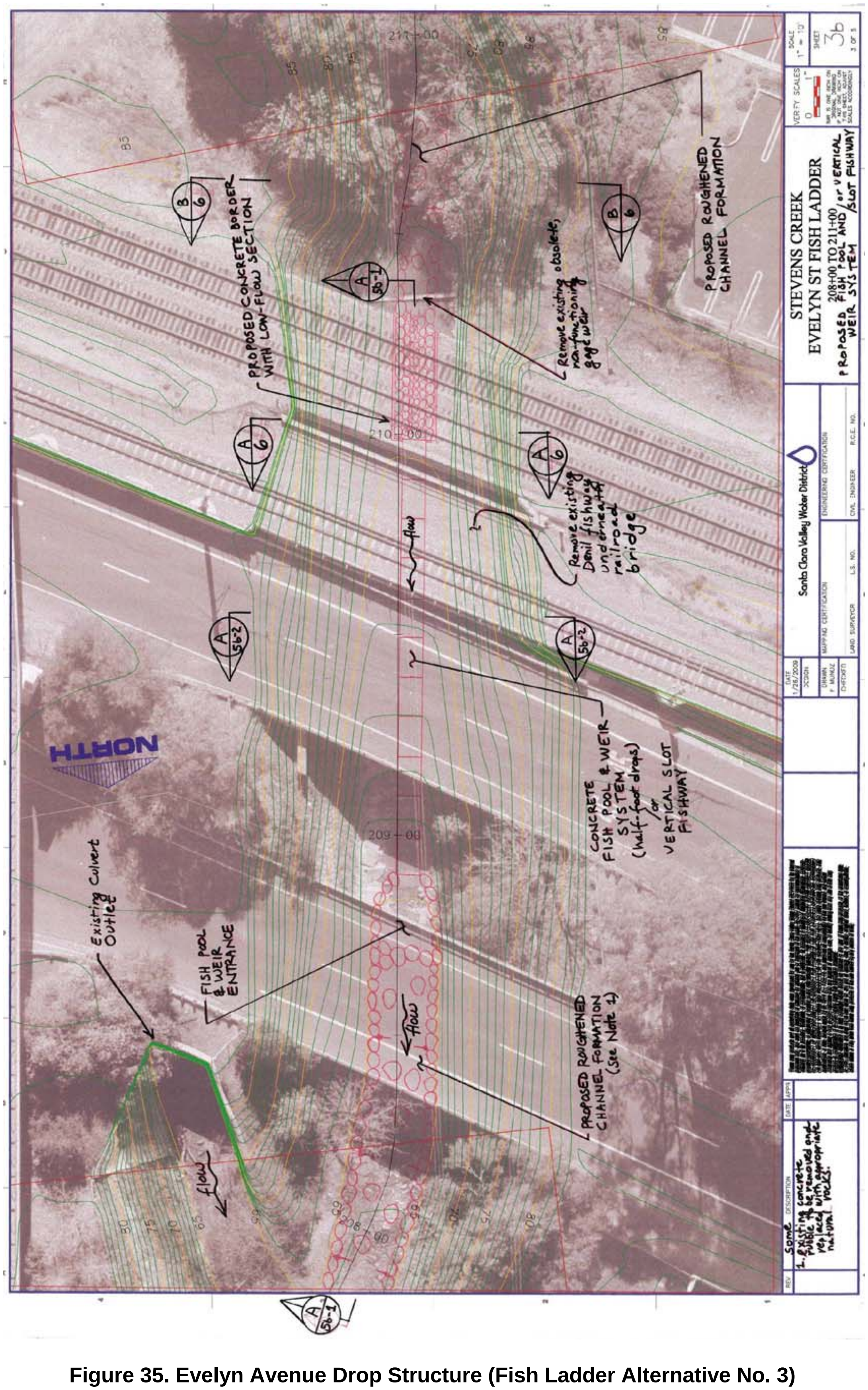

STEVENS CREEK
EVELYN ST FISH LADDER
208+00 TO 211+00
PROPOSED FISH POOL AND/or VERTICAL WEIR SYSTEM /SLOT FISHWAY
Santa Clara Valley Water District
SCALE 1" = 10'
SHEET 3b
NORTH
PROPOSED CONCRETE BORDER WITH LOW-FLOW SECTION
Remove existing non-functioning gage weir
PROPOSED ROUGHENED CHANNEL FORMATION
Remove existing Denil fishway underneath railroad bridge
CONCRETE FISH POOL & WEIR SYSTEM (half-foot drops) or VERTICAL SLOT FISHWAY
Existing Culvert Outlet
FISH POOL & WEIR ENTRANCE
PROPOSED ROUGHENED CHANNEL FORMATION (See Note 1)
flow
flow
flow
217+00
210+00
209+00
208+00
85
80
75
70
65
A/6
B/6
A/56-1
A/56-2
Some
1. Existing concrete rubble to be removed and replaced with appropriate natural rocks.

Figure 35. Evelyn Avenue Drop Structure (Fish Ladder Alternative No. 3)

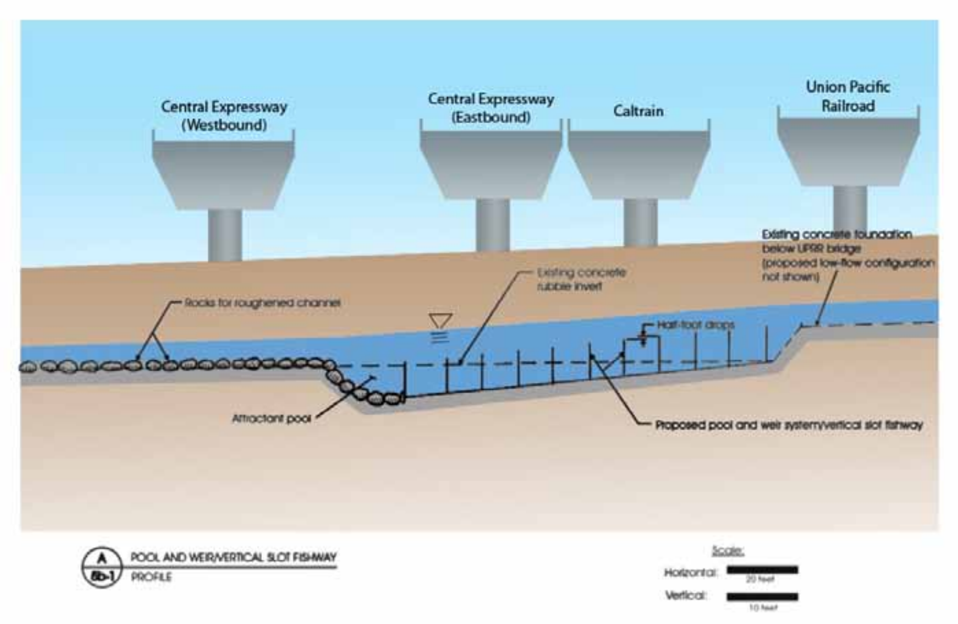

Central Expressway (Westbound)
Central Expressway (Eastbound)
Caltrain
Union Pacific Railroad
Existing concrete foundation below UPRR bridge (proposed low-flow configuration not shown)
Existing concrete rubble invert
Rocks for roughened channel
Half-foot drops
Attractant pool
Proposed pool and weir system/vertical slot fishway
A
5b-1
POOL AND WEIR/VERTICAL SLOT FISHWAY
PROFILE
Scale:
Horizontal:
20 feet
Vertical:
10 feet

Figure 36. Evelyn Avenue Drop Structure (Fish Ladder Alternative No. 3)

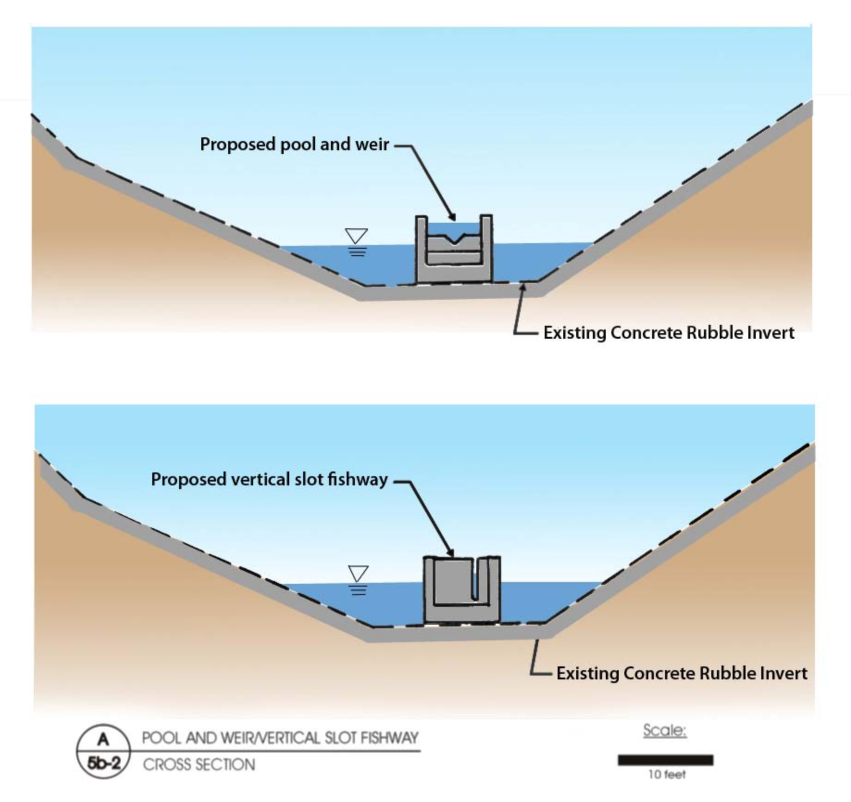

Proposed pool and weir
Existing Concrete Rubble Invert
Proposed vertical slot fishway
Existing Concrete Rubble Invert
A
5b-2
POOL AND WEIR/VERTICAL SLOT FISHWAY
CROSS SECTION
Scale:
10 feet

Figure 37. Evelyn Avenue Drop Structure (Fish Ladder Alternative No. 3)

Feasibility Assessment

With this alternative, the expected operations and maintenance frequency would probably occur more than twice per year. Migrating fish would likely be stranded if there are very low-flows coming through the system. There is a high probability for wildlife species to be impeded in their migration, since there may not be ample flat areas for these species to use. There would also be a number of concrete breaks in the structure that would pose as impediments to the wildlife species. However, these impediments could probably be mitigated for by adding a somewhat sloping flat section with side railing protection, immediately adjacent at either side of the fish ladder structure. This sloped flat area could at times probably be used also as an access point for operations and maintenance staff. The encroachment of the concrete structure could have a minor local negative impact on flood capacity. Since the existing surroundings of the structure are already mostly concrete, there would be no direct impact to erosion prevention or inducement. There may be minor impacts to existing vegetation due to the construction of the stream log and boulder structures, but this could probably be mitigated for. The most challenging aspect of this alternative is construction access. However, compared with the construction of the scour pool and weir system, the amount of materials to be removed and placed would be significantly less. Historically, this concept has been used in several locations, including the concrete pool-and-weir fish ladder in Guadalupe River, adjacent to the District Headquarters. Therefore, the estimated frequency of operations and maintenance for this alternative should not change. This alternative is considered hardscape and would likely require a softening effect to conform to the existing channel.

Alternative No. 4 –Vertical Slot Fishway Option

Description

This alternative proposes to remove the existing Denil structure and create a vertical slot fishway downstream of the arched Union Pacific Railroad crossing. The associated Denil fish attractant pool, along with the concretized rock-like rubbles, will also be removed. The jump heights from weir to weir would be set at maximum half-foot drops. Ninety percent of the low-flows during the migration period from September 15 to May 31 results in less than 1 cubic feet per second (cfs) flow. The pools will be designed to accommodate at least a flow of 1 cfs.

The vertical slot fishway will terminate halfway between the arched bridge and the downstream end of the existing box culvert. Therefore, immediately downstream of the fish attractant pool, a low-flow roughened channel section will be constructed and conform to downstream of the existing box culvert. Directly below the bridge, a low-flow section with natural rocks will be created. The width of this low-flow section will be restricted by two low-level retaining walls, which will be doweled to the upper foundation of the arched bridge. Upstream of the bridge, a low-flow narrow roughened channel section will be created, up to and conform to upstream of the existing box culvert. The obsolete gauging weir will also be removed. The low-flow roughed section next to the invert entrance of the box culvert will be configured, allowing the previous as-built condition of the concrete invert to emerge, with at least two feet higher invert elevation than the low-flow roughened section. Two stream log and boulder structures will be constructed just upstream of the box culvert entrance, at the lower portion of the east bank. The function of these structures will be to concentrate and maintain the low-flows in the main channel. Additional rocks opposite the lower portion of the west bank may be required to prevent erosion potential on the west bank.

Refer to Figures 28 and 35 for the plan views of this alternative.

Refer to Figure 36 for the pertinent profile of the vertical slot fishway system.

Refer to Figures 31 to 34, and 37 for the pertinent sections.

Refer to Figures 25 and 26 for a sample view and schematic detail of the vertical slot fishway.

Feasibility Assessment

With this alternative, the expected operations and maintenance frequency would probably occur once per year to ensure the full vertical slot openings of the fishway are functioning. Migrating fish would not likely be stranded even if there are very low-flows coming through the system; the full open vertical slot and the straight bottom slope of the fishway should allow most flows to pass through and not cause stranding of fish. There is a high probability for some wildlife species, such as western pond turtles, which are too wide to go through the vertical slot, to be impeded in their migration. However, these impediments could probably be mitigated for by adding a somewhat sloping flat section with side railing protection, immediately adjacent at either side of the fish ladder structure. This sloped flat area could at times probably be used also as an access point for operations and maintenance staff. The encroachment of the concrete structure could have a minor local negative impact on flood capacity. Since the existing surroundings of the structure are already mostly concrete, there would be no direct impact to erosion prevention or inducement. There may be minor impacts to existing vegetation due to the construction of the stream log and boulder structures, but this could probably be mitigated for. The most challenging aspect of this alternative is construction access. However, compared with the construction of the scour pool and weir system, the amount of materials to be removed and placed would be significantly less. Historically, this concept has been used in some locations (including Niles Dam, St. Joseph River, Berrien County, MI), but has not been extensively used compared with concrete pool and weir structures. Still, the estimated frequency of operations and maintenance for this alternative should not likely change. This alternative is considered hardscape and would likely require a softening effect to conform to the existing channel.

Table 2 – Feasibility Alternatives Matrix for Evelyn Avenue				
Evelyn Avenue Issues and Concerns	**Alternative No. 1 No Project Option**	**Alternative No. 2 Scour Pool & Weir Option**	**Alternative No. 3 Concrete Pool & Weir Option**	**Alternative No. 4 Vertical Slot Fishway Option**
1. Project Cost	Construction: $ 0.00 mil 30-Yr Maint: $ 1.46 mil Total: $ 1.46 mil Rating = 8	Construction: $ 1.30 mil 30-yr Maint: $ 0.54 mil Total: $ 1.84 mil Rating = 7	Construction: $ 1.30 mil 30-yr Maint: $ 0.63 mil Total: $ 1.93 mil Rating = 7	Construction: $ 1.40 mil 30-yr Maint: $ 1.05 mil Total: $ 2.45 mil Rating = 6
2. Maintainability and Operability	Annual maint frequency: >2x Can fish likely be stranded during extreme low-flows? Yes Rating = 0	Annual maint frequency: 1x Can fish likely be stranded during extreme low-flows? Not likely Rating = 8	Annual maint frequency: >2x Can fish likely be stranded during extreme low-flows? Yes Rating = 0	Annual maint frequency: 1x Can fish likely be stranded during extreme low-flows? Not likely Rating = 6
3. Passage for other wildlife species	Existing structure does not allow adequate passage Rating = 1	Allows full adequate passage Rating = 10	Allows full adequate passage when mitigated Rating = 9	Allows full adequate passage when Mitigated Rating = 7
4. Flood Capacity Impact	No impact. Rating = 10	Moderate negative impact. Rating = 6	Moderate negative impact. Rating = 6	Moderate negative impact. Rating = 6
5. Geomorphic Enhancement	None Rating = 5	None Rating = 5	None. Rating = 5	None. Rating = 5
6. Community Impacts	No impacts to vegetation or trail. Rating = 10	Minor impacts to vegetation, but can be mitigated. Rating = 8	Minor impacts to vegetation, but can be mitigated. Rating = 8	Minor impacts to vegetation, but can be mitigated. Rating = 8
7. Constructability	The existing structure does not have to be constructed. This is considered positive Rating = 10	Construction would be most challenging of all alternatives. Hauling of rocks may be more difficult than concrete placement. Rating = 4	Construction would be challenging. Access is limited. Rating = 5	Construction would be challenging. Access is limited. Rating = 5
8. Potential Lifespan of Facility	Existing Denil structure is not properly located and does not function in most seasons. See also problem definition report. Rating = 2	Concept is somewhat new and historically untested. Rating = 7	Has been used for many years. Rating = 10	Use of concept less than pool and weir. Rating = 8
9. Aesthetics	Existing Denil structure is not properly located. Considered an eye sore element. Rating = 4	Very favorable natural alternative. Rating = 10	Less favorable structure (concrete), but can be mitigated. Rating = 7	Less favorable structure (concrete), but can be mitigated. Rating = 6
TOTAL RATING SCORE:	**50**	**65**	**57**	**57**

3.3.3 Fremont Avenue Alternatives Description and Feasibility Assessment

What follows is a description of each alternative and its particular feasible assessment summary. To obtain the rankings and ratings for the feasibility assessment of all alternatives, refer to **Table 3, Feasibility Alternatives Matrix for Fremont Avenue**.

Alternative No. 1 – No Project Option

Description

This alternative does not include any improvements to the facility. It maintains the existing condition of the facility.

Feasibility Assessment

With this alternative, there is no impact to flood capacity; no geomorphic enhancement of the facility; nor impacts to existing vegetation or the existing trail. However, without improvements to the existing facility, partial barriers to passage of fish and other aquatic species will exist, especially during low flow periods. The location of the existing Denil structure itself is not located appropriately to capture low-flows. The structure will continue to experience blockage, which can significantly impede fish migration. The existing facility does not allow maintenance crews or operations staff adequate access to remove this blockage during intermediate to high flows.

Alternative No. 2 – Option to Relocate Existing Denil-type Fish Ladder from East to West Side of Drop Structure

Description

The existing slope of the drop structure is roughly 17 percent. Choosing this slope was not trivial. Denil-type structures usually were designed at maximum slopes of 17 percent. From an economic viewpoint, retaining the existing drop structure would be the least costly alternative to improving the conditions at the site. However, this alternative would still require replacement of the existing Denil-type structure with another better functioning alternative. Based on latest technical information for fish ladders, the only other alternative that would be a viable replacement to the Denil-type structure, at 17 percent slope, would be the Alaskan Steeppass (ASP), which can accommodate slopes of 25, even 33, percent. The ASP is a specific style of Denil fishway originally developed for remote installations. The ASP is more efficient than the standard Denil in controlling velocities; it has a more complex set of baffles that are angled upstream into the flow. However, the concerns regarding debris and blockage are more critical in an ASP than a Denil, because an ASP has smaller open dimensions. The ASP may have a similar effect as a Denil on the target fish species in that a certain proportion of the fishes may have a natural aversion to entering an artificial fishway.

Therefore, the only solution, if the existing drop structure is retained, is to maintain the Denil structure. The only significant improvement that can be achieved for this alternative is to relocate the Denil structure to the west side of the drop structure. By relocating the Denil structure, low flows that normally occur outside of a bend would readily pass through the Denil structure. Currently, the Denil structure is located in the inside portion of a bend, where upstream of the bend, sediments normally accumulate—thus, partially blocking the entrance/exit at the top of the fish ladder. When relocating the Denil structure to the west, a narrow maintenance access area could potentially be constructed between the existing westerly vertical wall structure and the relocated Denil structure, opposite the intermediate/high flows cascading over the drop structure. This would allow Water District maintenance crews or operations staffs to more easily remove most of the significant blockages.

The existing Denil structure shows substantial wear and tear along the chute wall, and the baffle plates have similar signs of wear and tear from flow and debris scouring impacts. Presently little information exists on the replacement of components or repair of the existing structure. It remains to be seen whether relocating the Denil structure to the outside bend along the "scour path" of the high flow events would present additional, accelerated wear patterns requiring more aggressive preventative or corrective maintenance or replacement schedule to the fishway portion of the structure itself.

The existing channel westerly and immediately downstream of the drop structure, which has been undermined, will have to be converted to a fish attractant pool.

The highly incised and armored channel in this reach, associated with the constructed drop structure and hardened banks, constrains traverse by other semi aquatic species, such as western pond turtles and red-legged frogs. Relocating the Denil structure will still likely pose similar obstacle and passage resistance to these other aquatic resources.

Figure 38 shows the plan view of this alternative.

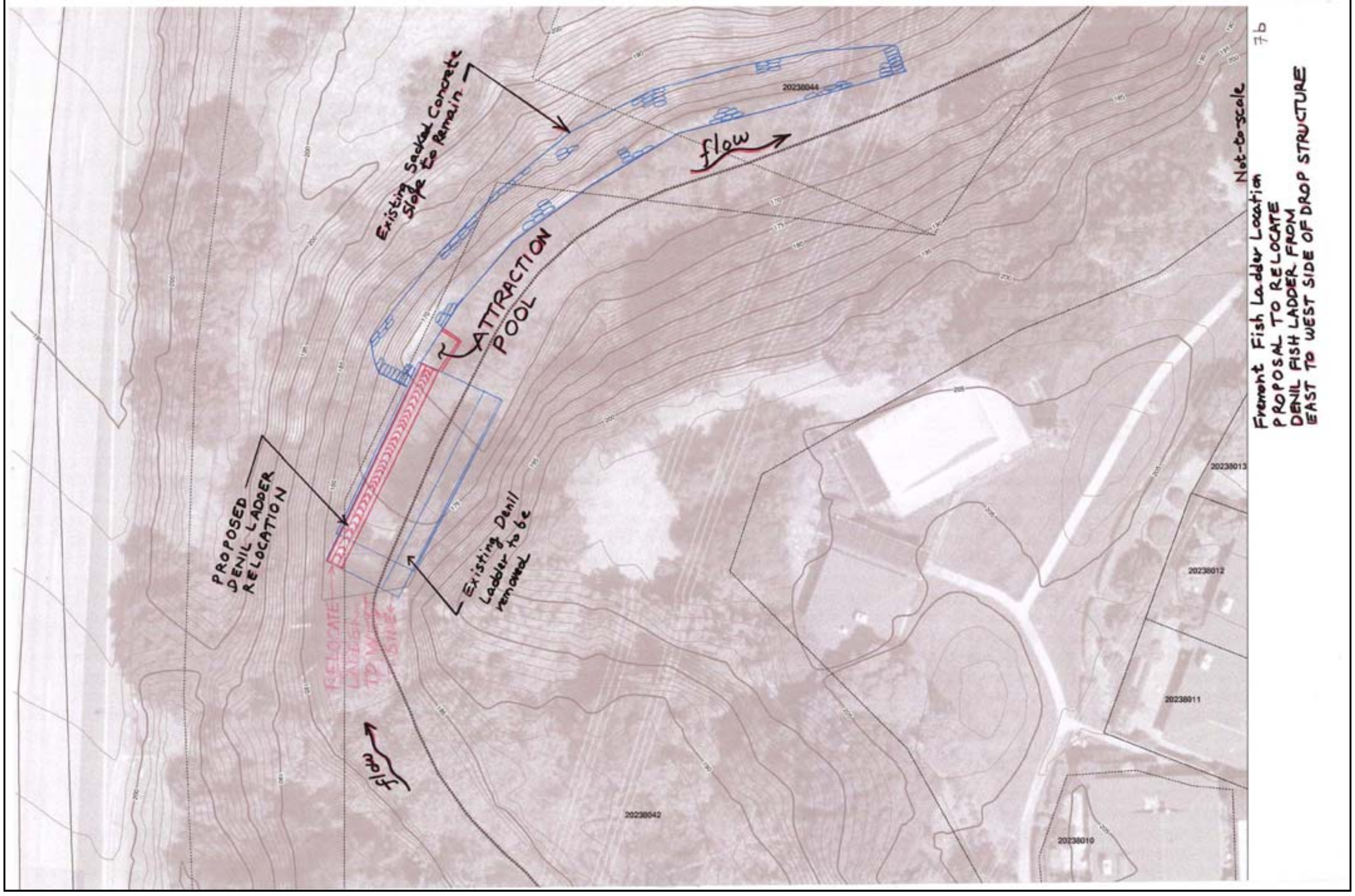

Existing Sacked Concrete Slope to Remain
flow
ATTRACTION POOL
PROPOSED DENIL LADDER RELOCATION
Existing Denil Ladder to be removed
RELOCATE LADDER TO WEST SIDE
flow
Fremont Fish Ladder Location
PROPOSAL TO RELOCATE DENIL FISH LADDER FROM EAST TO WEST SIDE OF DROP STRUCTURE
Not-to-scale
7b
20238044
20238013
20238012
20238011
20238010
20238042

Figure 38. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 2)

Feasibility Assessment

With this alternative, the expected operations and maintenance frequency would probably occur once per year. Migrating fish would likely be stranded if there are very low flows coming through the system. There is no impact to flood capacity, no geomorphic enhancement of the facility, nor impacts to existing vegetation or any proposed trail. There may still be a moderate probability for some wildlife species, such as western pond turtles, to be impeded in their migration, since the proposed flat access area adjacent the fish ladder would be at a steep slope of 17 percent. Construction access may be a bit challenging, but can probably be managed. Historically, this concept has been used in several locations, including various locations within the county. Therefore, the estimated frequency of operations and maintenance for this alternative should not change. This alternative does not affect the aesthetics of the existing concrete channel configuration.

Alternative No. 3 – Scour Pool and Weir Option

Description

This alternative proposes to remove the Denil structure and portions of the drop structure and create a series of scour pools and weirs, composed of natural rocks, and rock riprap to simulate a natural pool and weir system. The portion of the drop structure to be removed will be the easterly wall and the main drop structure. The westerly wall will be left intact, but reinforced, since this wall structure currently holds the majority of the soils between the channel and Highway 85, for this area. The jump heights from weir to weir would be set at maximum half-foot drops. The initial slope of the scour pool and weir system is based on the natural slope of the existing channel upstream and downstream of the system. Sizing of the rocks for the scour pools and weirs were calculated with reference to existing dimensions for rock sizes that are currently situated in the natural pools and riffles upstream of the existing drop structure.

Figures 39 and 40 show the plan views of this alternative.

Figure 41 shows the pertinent profile of the scour pool and weir system.

Figures 42 to 45 show the pertinent sections.

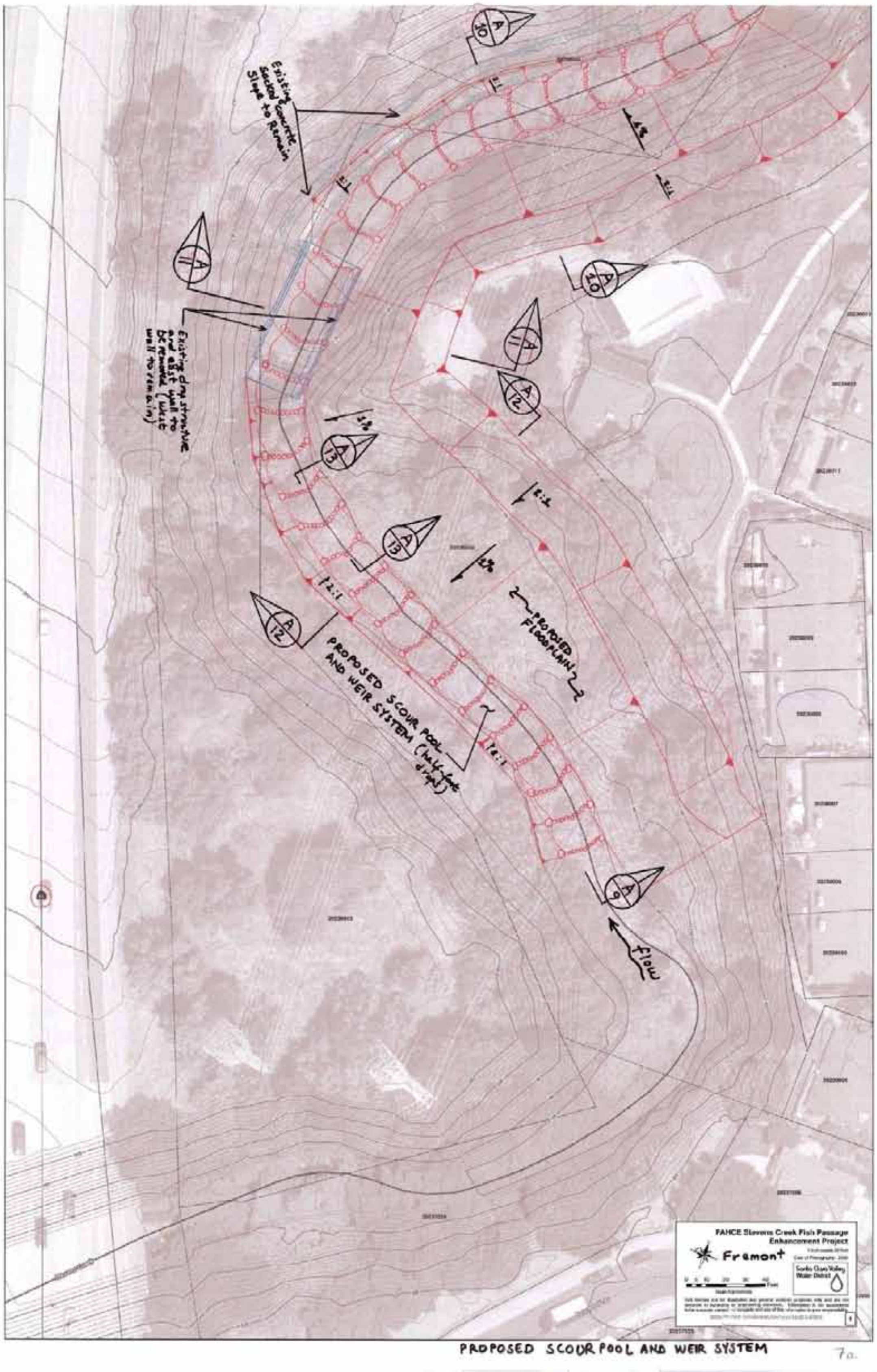

Existing Sealed Concrete Slope to Remain
Existing drop structure and abut wall to be removed (west wall to remain)
PROPOSED SCOUR POOL AND WEIR SYSTEM (half-foot drops)
PROPOSED FLOODPLAIN
Flow
A 9
A 10
A 11
A 12
A 13
2:1
12:1
2%
FAHCE Stevens Creek Fish Passage Enhancement Project
Fremont
Santa Clara Valley Water District
Feet
PROPOSED SCOUR POOL AND WEIR SYSTEM
7a.

Figure 39. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 3)

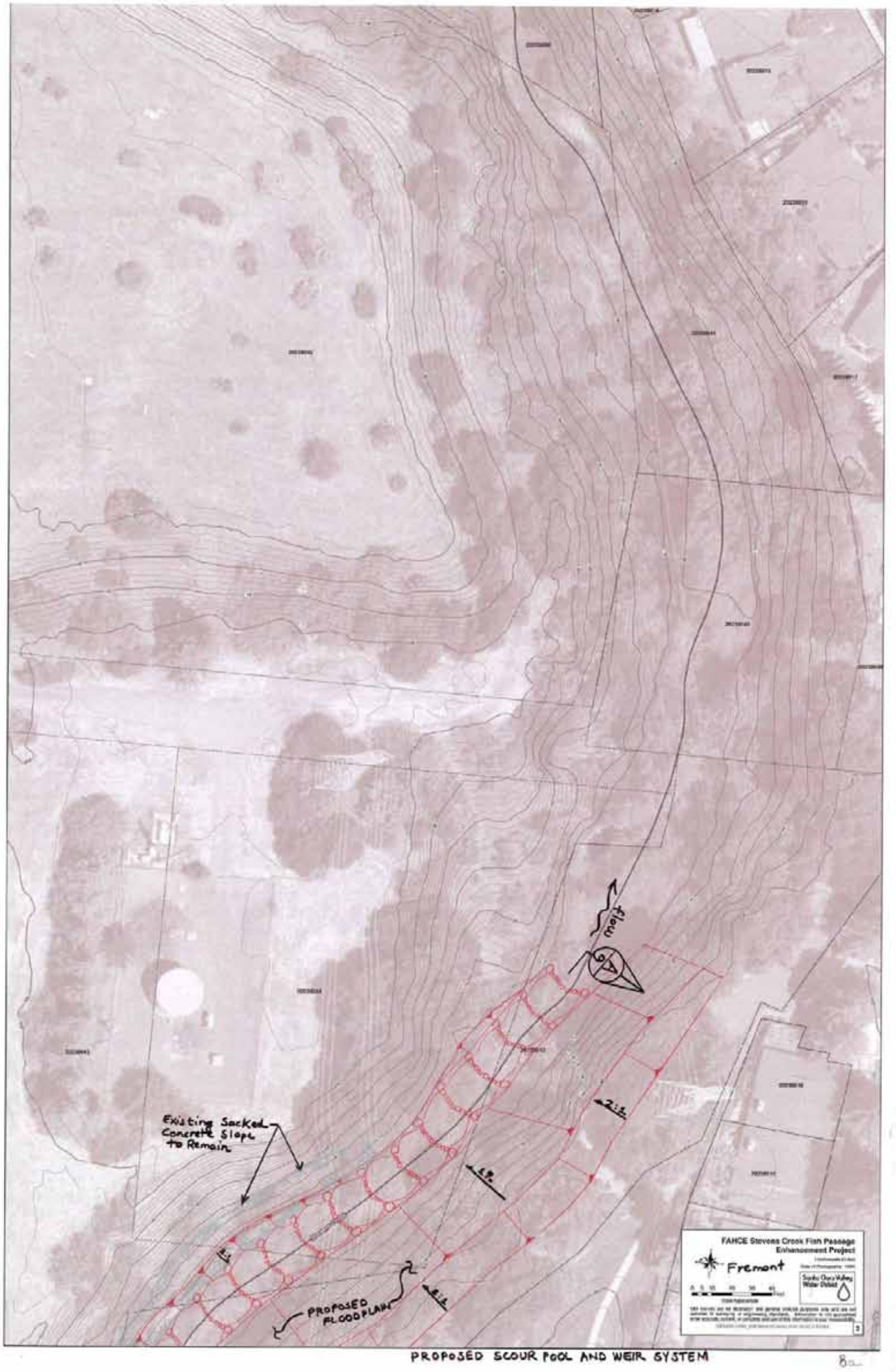

flow
Existing Sacked Concrete Slope to Remain
2:1
PROPOSED FLOODPLAIN
FAHCE Stevens Creek Fish Passage Enhancement Project
Fremont
Santa Clara Valley Water District
PROPOSED SCOUR POOL AND WEIR SYSTEM
8a

Figure 40. Fremont Avenue Drop Structure (Fish Alternative No. 3)

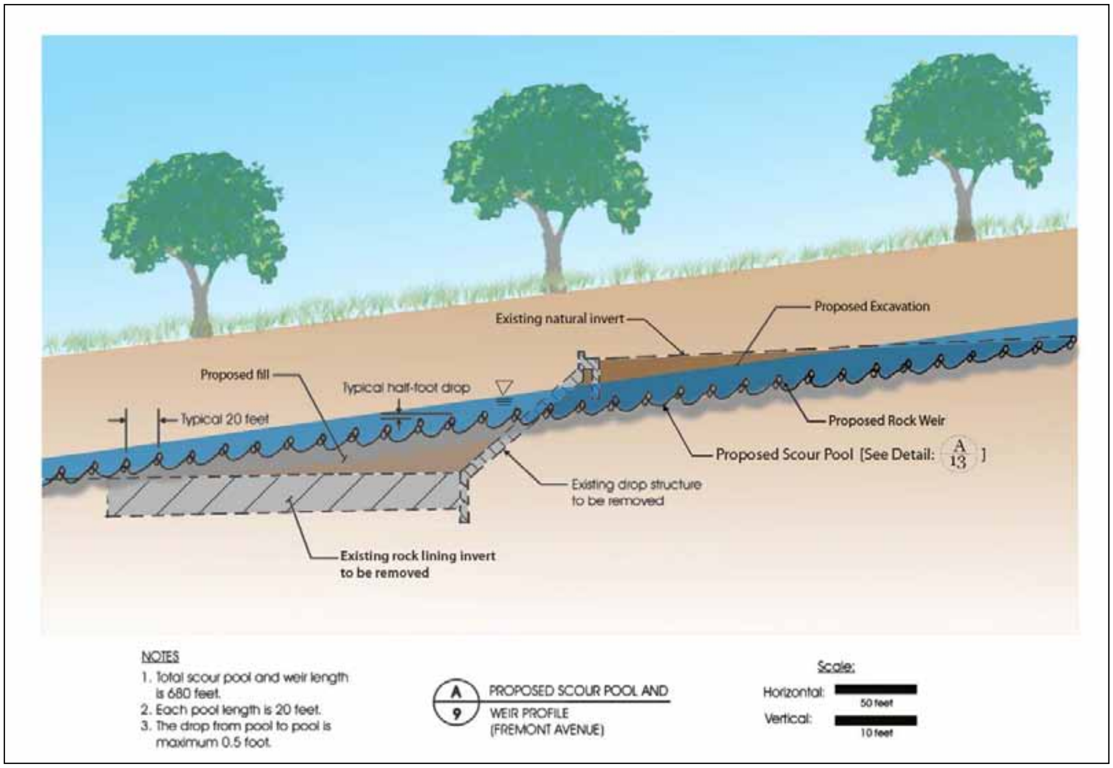

Existing natural invert
Proposed Excavation
Proposed fill
Typical half-foot drop
Typical 20 feet
Proposed Rock Weir
Proposed Scour Pool [See Detail: A 13]
Existing drop structure to be removed
Existing rock lining invert to be removed
NOTES
1. Total scour pool and weir length is 680 feet.
2. Each pool length is 20 feet.
3. The drop from pool to pool is maximum 0.5 foot.
A 9
PROPOSED SCOUR POOL AND WEIR PROFILE (FREMONT AVENUE)
Scale:
Horizontal:
50 feet
Vertical:
10 feet

Figure 41. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 3)

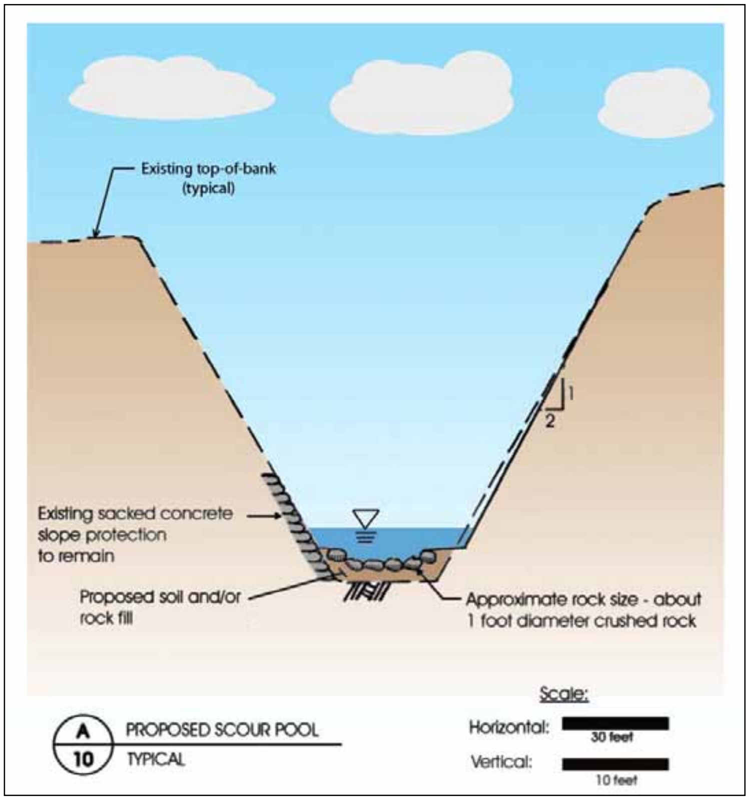

Existing top-of-bank (typical)
1
2
Existing sacked concrete slope protection to remain
Proposed soil and/or rock fill
Approximate rock size - about 1 foot diameter crushed rock
Scale:
A 10
PROPOSED SCOUR POOL TYPICAL
Horizontal:
30 feet
Vertical:
10 feet

Figure 42. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 3)

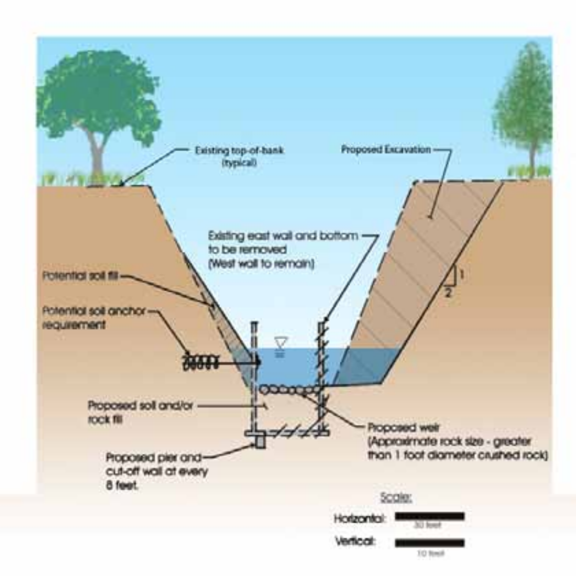

Existing top-of-bank (typical)
Proposed Excavation
Existing east wall and bottom to be removed (West wall to remain)
Potential soil fill
Potential soil anchor requirement
1
2
Proposed soil and/or rock fill
Proposed weir (Approximate rock size - greater than 1 foot diameter crushed rock)
Proposed pier and cut-off wall at every 8 feet.
Scale:
Horizontal:
30 feet
Vertical:
10 feet

Figure 43. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 3)

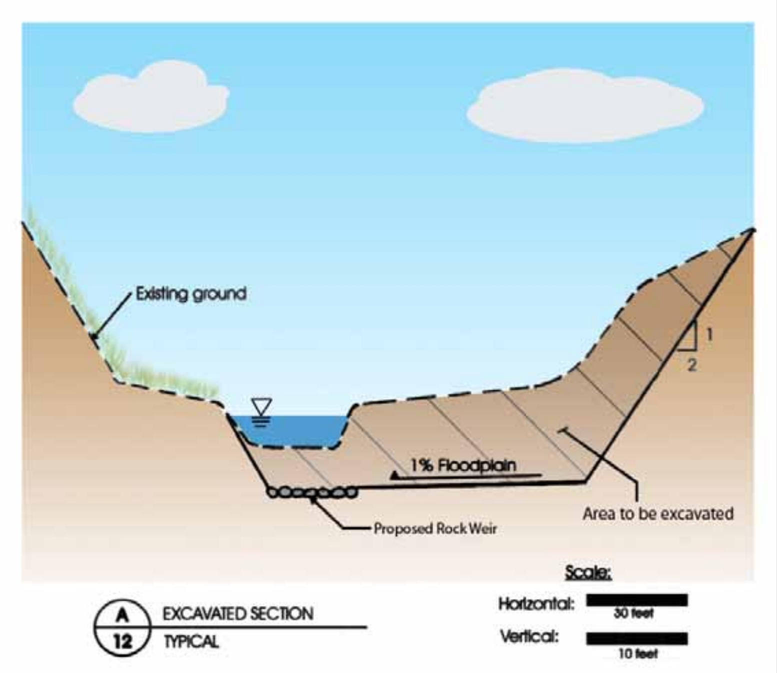


Figure 44. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 3)

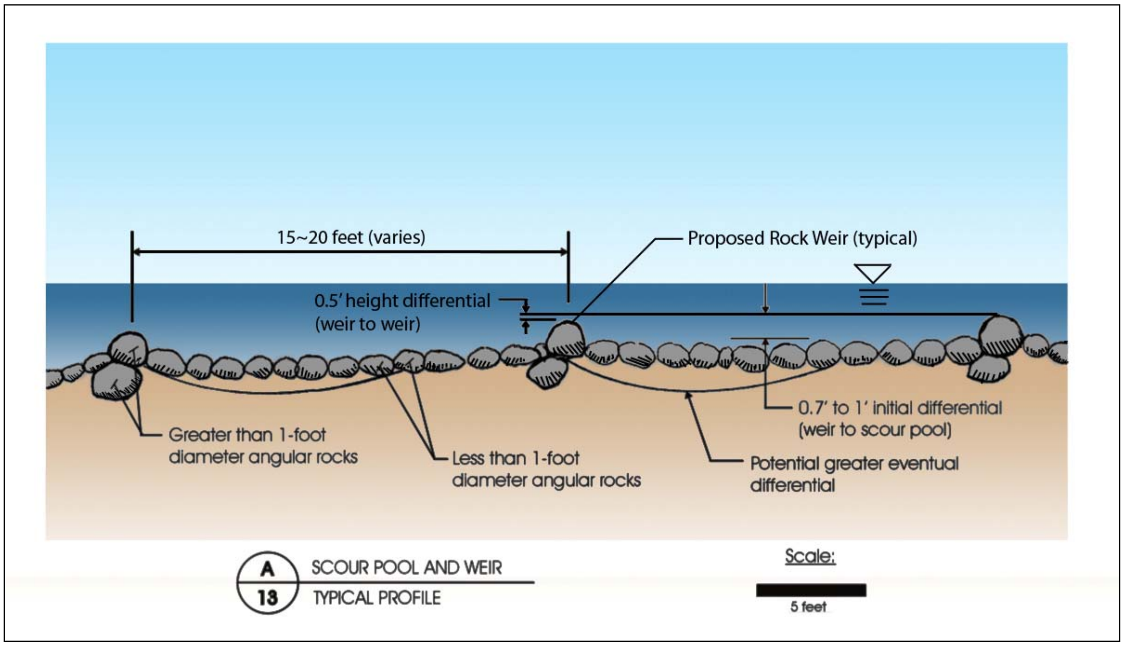

15~20 feet (varies)
Proposed Rock Weir (typical)
0.5' height differential (weir to weir)
0.7' to 1' initial differential (weir to scour pool)
Greater than 1-foot diameter angular rocks
Less than 1-foot diameter angular rocks
Potential greater eventual differential
A
13
SCOUR POOL AND WEIR
TYPICAL PROFILE
Scale:
5 feet

Figure 45. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 3)

Feasibility Assessment

Of all the three modification options, this would be the most expensive, and also the one with the most positive and negative impacts. The positive impacts associated with this alternative are:

- A more natural system introduced into the corridor
- Hardscape areas are reduced
- A floodplain easterly of the corridor is expanded upstream and downstream of the existing drop structure, providing better relief from flows coming downstream—thus, reducing creek erosion potential
- A restorative effect for the creek environment
- Improved passage for other wildlife species

The negative impacts associated with this alternative are:

- Temporary impacts to existing native vegetation
- Potential temporal impacts to resident wildlife and other species
- Financial impact due to higher construction cost compared with other alternatives
- Financial impact to maintenance and operational costs—scour pools and weirs may adjust due to evolution of the creek in a natural condition—future adjustment of the rocks may likely be required

Alternative No. 4 –Vertical Slot Fishway Option

Description

This alternative proposes to remove the existing Denil structure, its associated fish attractant pool, and create a vertical slot fishway on the westerly side of the drop structure. The jump heights from weir to weir would be set at maximum half-foot drops. Ninety percent of the low flows during the migration period from September 15 to May 31 results in less than 1 cubic feet per second (cfs) flow. The pools will be designed to accommodate at least the 1 cfs flow.

The vertical slot fishway will continue downstream beyond the limit of the drop structure and conform to the existing channel. The sacked concrete slope protection on the westerly slope would remain.

Figure 46 shows the plan view of this alternative.

Figure 47 shows the pertinent profile of the vertical slot fishway system.

Figure 48 shows the pertinent section.

Refer to Figures 25 and 26 for a sample view and schematic detail of the vertical slot fishway.

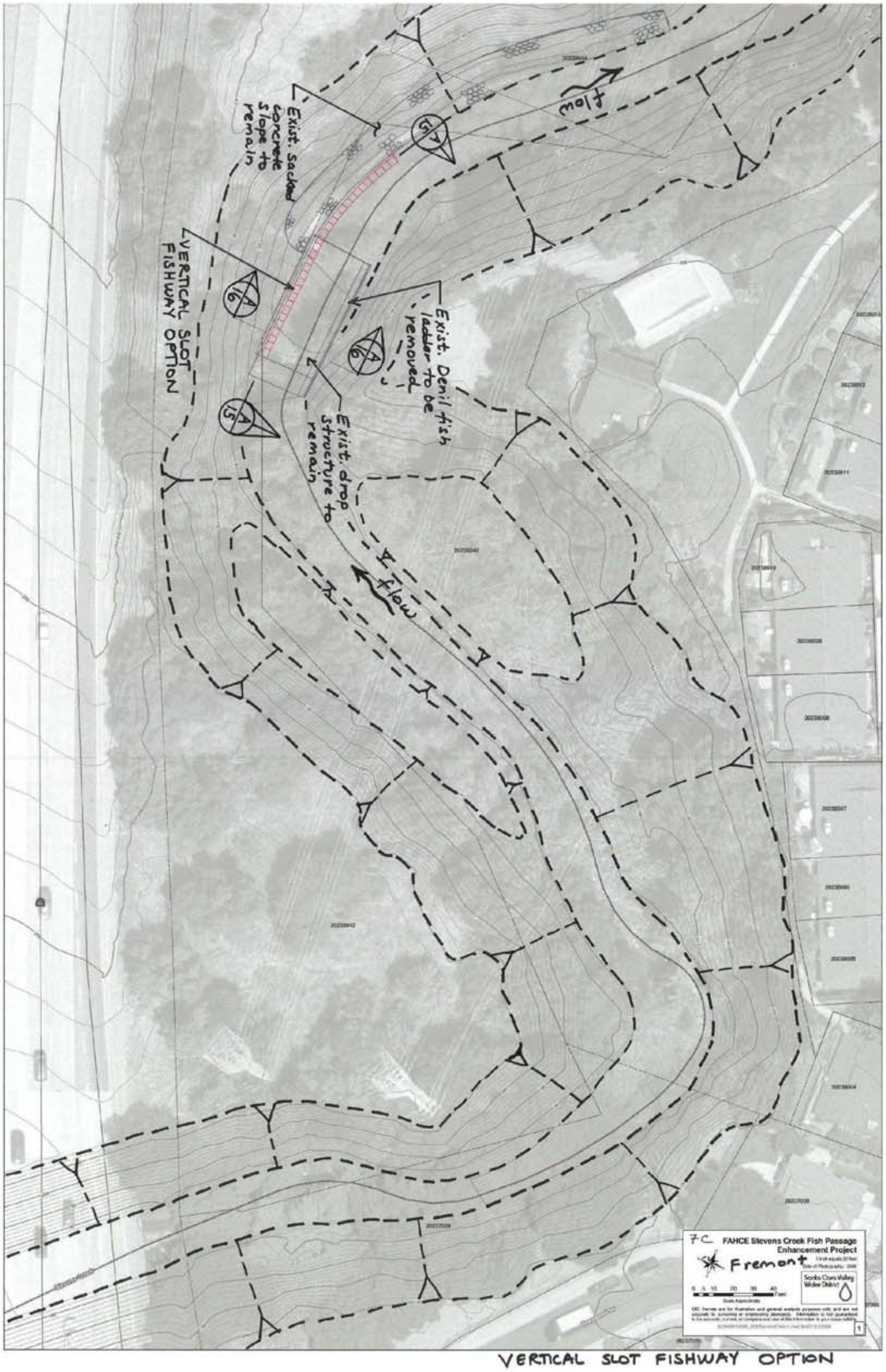

Exist. Sacked concrete slope to remain
VERTICAL SLOT FISHWAY OPTION
Exist. Denil fish ladder to be removed
Exist. drop structure to remain
flow
flow
A 16
A 16
A 15
7C
FAHCE Stevens Creek Fish Passage Enhancement Project
Fremont
Santa Clara Valley Water District
0 5 10 20 30 40 Feet
Scale Approximate
1
VERTICAL SLOT FISHWAY OPTION

Figure 46. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 4)

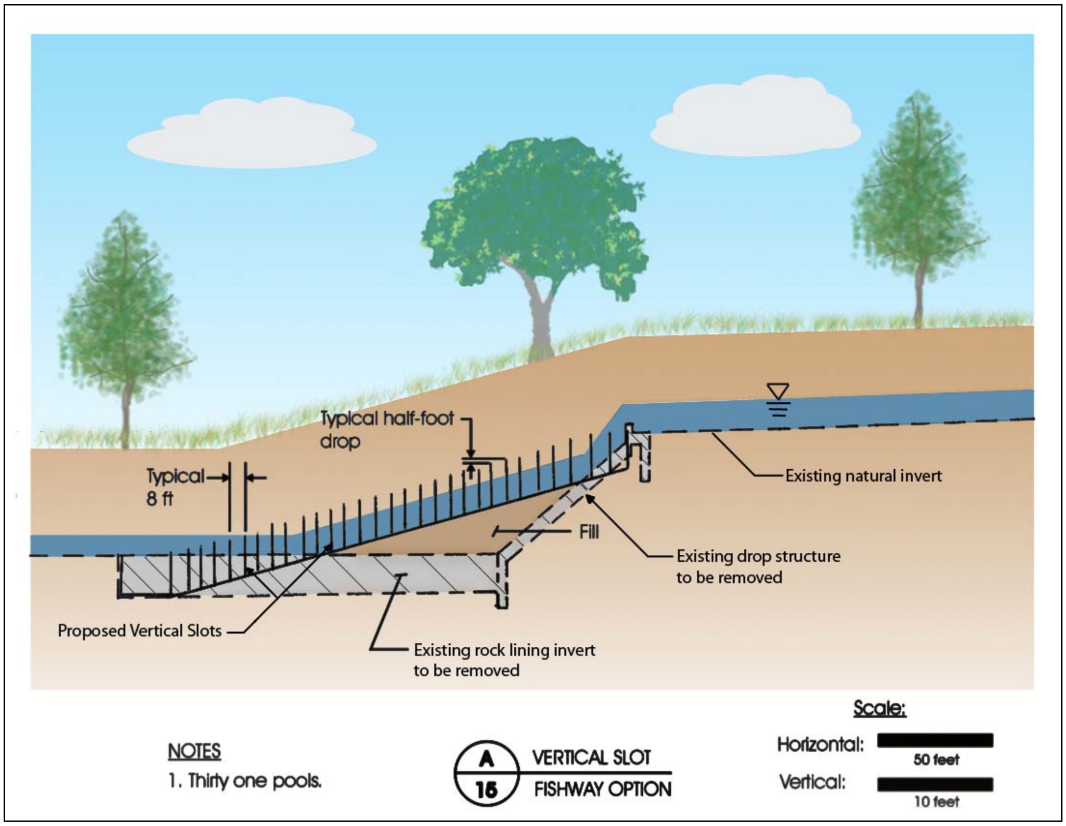


Figure 47. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 4)

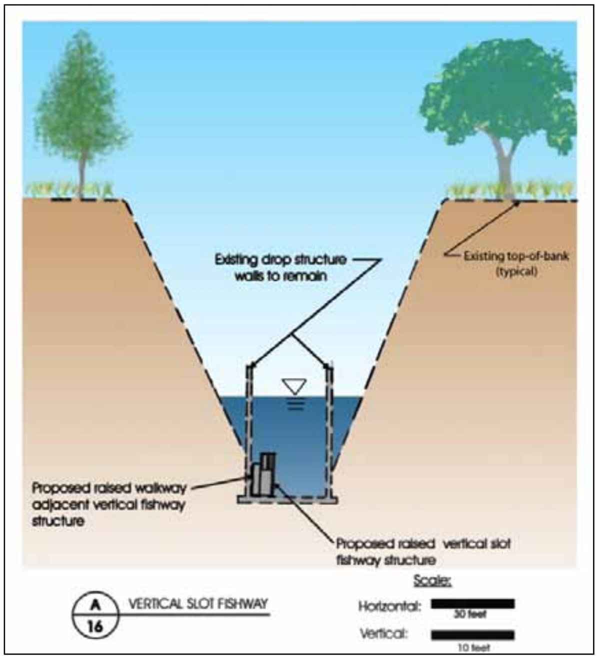

Existing drop structure walls to remain
Existing top-of-bank (typical)
Proposed raised walkway adjacent vertical fishway structure
Proposed raised vertical slot fishway structure
Scale:
A
16
VERTICAL SLOT FISHWAY
Horizontal:
30 feet
Vertical:
10 feet

Figure 48. Fremont Avenue Drop Structure (Fish Ladder Alternative No. 4)

Feasibility Assessment

With this alternative, the expected operations and maintenance frequency would probably occur once per year to ensure the full vertical slot opening of the fishway is functioning. Migrating fish would not likely be stranded even if there are very low flows coming through the system; the full open vertical slot and the straight bottom slope of the fishway should allow most flows to pass through and not cause stranding of fish. There is a high probability for some wildlife species, such as western pond turtles, which are too wide to go through the vertical slot, to be impeded in their migration. However, this impediment could probably be mitigated for by adding an adjacent flat slope area easterly or westerly, and outside of, but connected to, the vertical slot fishway. This flat area could probably also be used as an access point for operations and maintenance staff. There is no impact to flood capacity, no geomorphic enhancement of the facility, nor impacts to any proposed trail. There may be very minor, temporal impacts to existing vegetation. Construction access may be a bit challenging, but can probably be managed. Compared with the construction of the scour pool and weir system, the amount of materials to be removed and placed would be significantly less. Historically, this concept has been used in some locations, but has not been extensively used compared with Denil structures. Still, the estimated frequency of operations and maintenance for this alternative should not likely change. This alternative is considered hardscape and would likely require a softening effect to conform to the existing channel.

Table 3 - Feasibility Alternatives Matrix for Fremont Avenue

Fremont Avenue Issues and Concerns	Alternative No. 1 No Project Option	Alternative No. 2 Relocate Denil Structure	Alternative No. 3 Scour Pool & Weir Option	Alternative No. 4 Vertical Slot Fishway Option
1. Project Cost	Existing structure does not allow proper maintenance during critical fish passage. Cannot be rated. Rating = 0	Construction: $ 0.6 mil 30-yr Maint: $ 1.26 mil Total: $ 1.86 mil Rating = 7	Construction: $ 2.5 mil 30-yr Maint: 0.54 mil Total: $ 3.04 mil Rating = 4	Construction: $ 0.80 mil 30-yr Maint: $ 1.05 mil Total: $ 1.85 mil Rating = 7
2. Maintainability and Operability	Annual maint frequency: Cannot be maintained during critical fish passage Can fish likely be stranded during extreme low flows? Yes Rating = 0	Annual maint frequency: 1x Can fish likely be stranded during extreme low flows? Yes Rating = 0	Annual maint frequency: 1x Can fish likely be stranded during extreme low flows? Not likely Rating = 8	Annual maint frequency: 1x Can fish likely be stranded during extreme low flows? Sometimes Rating = 6
3. Passage for other wildlife species	Structure does not allow adequate passage Rating = 1	Would partially allow adequate passage Rating = 4	Allows full adequate passage Rating = 10	Partially allows passage, but better than a Denil. Rating = 5
4. Flood Capacity Impact	No impact. Rating = 10	No impact. Rating = 10	No impact. Rating = 10	No impact. Rating = 10
5. Geomorphic Enhancement	None Rating = 5	None Rating = 5	Yes. Rating = 10	None. Rating = 5
6. Community Impacts	No impacts to vegetation or trail. Rating = 10	No long term impacts to vegetation or trail. Rating = 10	Long term impacts to vegetation or trail. Rating = 0	No long term impacts to vegetation or trail. Rating = 10
7. Constructability	The existing structure does not have to be constructed. This is considered positive. Rating = 10	Constructible—existing drop structure can accommodate fish ladder. Access is limited. Rating = 7	Most difficult to construct—major excavation, extensive vegetation removal, import of rock fill, removal of east wall structure. Rating = 4	More difficult to construct than relocating Denil fish ladder. Fishway to extend beyond extent of drop structure. Access is also limited. Rating = 6
8. Potential Lifespan of Facility	Has been used for many years, but its functionality for this location is not warranted. It functions ~ 50% of the time. Rating = 5	Has been used for many years. Rating = 8	Concept is somewhat new and historically untested. Rating = 3	Use of concept less than pool and weir. Rating = 7
9. Aesthetics	Existing Denil considered an eye sore element. Rating = 5	Less favorable structure (concrete), but can be mitigated. Rating = 6	Very favorable natural alternative. Rating = 10	Less favorable structure (concrete), but can be mitigated. Rating = 6
TOTAL RATING SCORE:	**46**	**57**	**59**	**62**

3.3.4 Stevens Creek Multiport Outlet Structure Description and Feasibility Assessment

What follows is a description of each alternative and its particular feasible assessment summary. To obtain the rankings and ratings for the feasibility assessment of all alternatives, refer to **Table 4, Feasibility Alternatives Matrix for Multiport Intake Structure**.

Alternative No. 1 – No Project Option

Description

This alternative maintains the existing condition of the facility.

Feasibility Assessment

With this alternative, summer volume releases for fish passage and groundwater recharge would not increase, but be consistent with existing operations. Potential to use a multiport intake at other dam and reservoir structures would not be realized, unless a pilot multiport intake structure was constructed at those other facilities. Funds could be used for other projects that benefit the same watershed area.

Alternative No. 2 – Option to Construct a Pilot Multiport Intake Structure

Description

This alternative is the construction of a pilot multiport intake structure. This alternative can have variations in the number and location of ports. At present, a thermal modeling study for the reservoir and a concurrent stream temperature study for the creek indicate that one additional intake port, besides the existing one, would be sufficient to increase the flow volume releases from the reservoir.

The size of the reservoir and the extent of stratification and depletion suggest that installing an operable intake structure that draws water from the cold hypolimnion and simultaneously from the warm epilimnion will provide the opportunity to mix the outlet blend to a managed target temperature that is “cool” while preserving the hypolimnion in a colder condition. This may provide an overall greater effective volume of water useable in the reservoir for the dual objectives of in-stream recharge and habitat management.

Figure 45 shows a schematic of the proposed multiport location and the target temperature to be achieved. The intent is to maximize the summer volume release from the dam, from both the epilimnion and hypolimnion regions, while achieving a maximum target temperature of 19 degrees Celsius at Interstate 280.

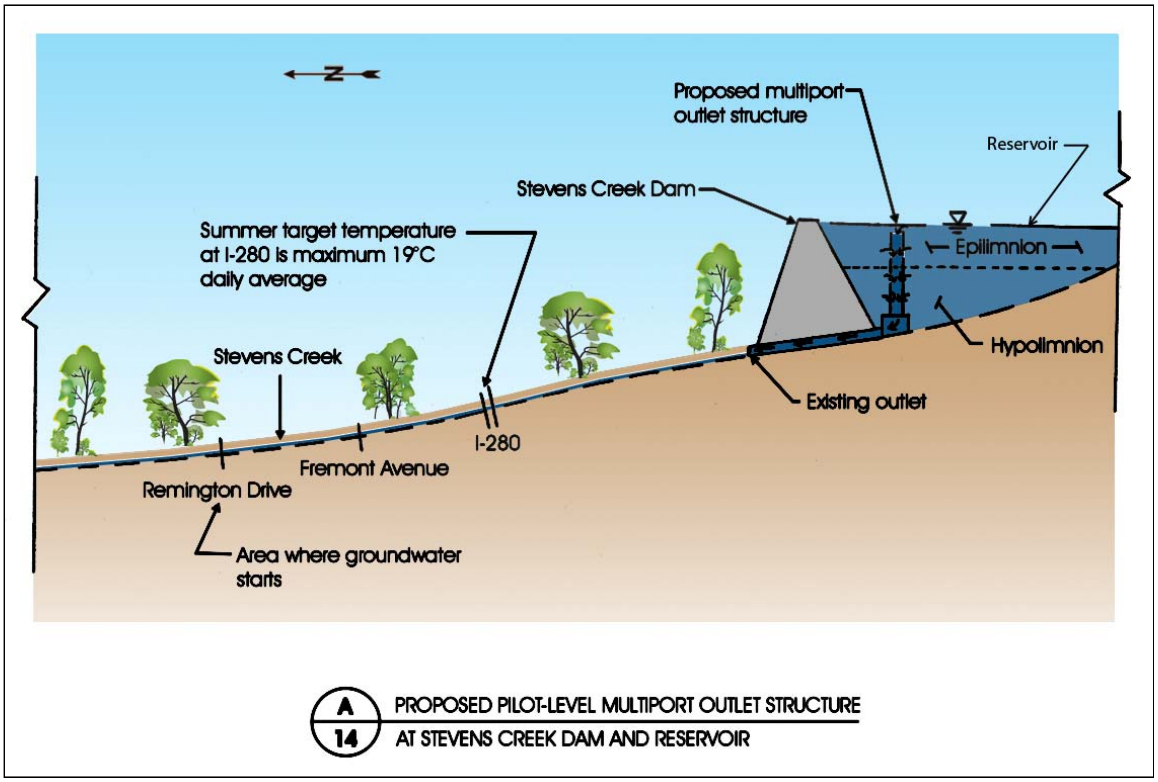

N
Proposed multiport outlet structure
Reservoir
Stevens Creek Dam
Summer target temperature at I-280 is maximum 19°C daily average
Epilimnion
Hypolimnion
Stevens Creek
Existing outlet
I-280
Fremont Avenue
Remington Drive
Area where groundwater starts
A
14
PROPOSED PILOT-LEVEL MULTIPORT OUTLET STRUCTURE
AT STEVENS CREEK DAM AND RESERVOIR

Figure 49. Stevens Creek Dam Proposed Multiport Intake Structure (Alternative No. 2)

Feasibility Assessment

With this alternative, summer volume releases for fish passage and groundwater recharge could significantly increase. Based on the performance of the multiport outlet structure, this type of structure could potentially be used at other dams and reservoirs. From a funding consideration, other projects within this watershed area would be re-prioritized.

Table 4 Feasibility Alternatives Matrix for Multiport Intake Structure		
Multiport Structure Issues and Concerns	**Alternative No. 1 No Project Option**	**Alternative No. 2 Multiport Intake Option**
1. Project Construction Cost	$ 0.0 million Rating = 10	$ 2.0 million Rating = 6
2. Water Availability for Fish Passage	No increase. Rating = 2	Potential increase in water availability to fish and other wildlife. Rating = 8
3. Water Availability for Groundwater Recharge	No increase. Rating = 2	Potential increase in water availability for groundwater recharge. Rating = 8
4. Pilot Model Opportunity to Benefit Other Reservoirs and Watersheds	No potential to use pilot model for other watershed systems. Rating = 2	Potential to use pilot model for other watershed systems. Rating = 8
5. Cost Priority Compared With Other Projects to Benefit Similar Area	Funds can be used for other projects that benefit the same watershed area. Rating = 10	This criterion is difficult to assess. So, the rating will be average. Rating = 4
TOTAL RATING SCORE:	**26**	**34**

4.0 STAFF-RECOMMENDED ALTERNATIVES

4.1 Selection of Alternatives

There are four sites of concern—three existing fish ladders sites with partial barriers and the thermal management of the existing reservoir and stream to optimize the flow volume releases during summer and warmer conditions.

For each fish ladder site, three alternatives, besides the "no project" alternative, were developed and evaluated. One natural alternative for either fish ladder site is to propose a rock scour pool and weir system, while the other hardscape alternatives are to maintain a Denil-type structure or construct a vertical slot fishway at the Fremont Avenue drop structure, and construct a concrete pool and weir system or vertical slot fishway at the Evelyn Avenue and Moffett Boulevard drop structures. Besides the "no project" alternative, only one alternative for the pilot-level multiport outlet structure at the Stevens Creek Dam and Reservoir was considered.

From a financial perspective, in terms of construction and maintenance, the hardscape alternatives would be the least costly. From an environmental perspective, the natural alternatives would be more compatible with the existing ecosystem, and enhancement and preservation of wildlife in Stevens Creek.

Based on the feasibility assessment of all the alternatives, taking into consideration the rating criteria and the final rating numbers, the likely staff recommended alternatives at each site are listed below.

- **For Moffett Boulevard, the preferred staff-recommended alternative would be Alternative No. 1 – Low Flow Channel Option.**
- **For Evelyn Avenue, the preferred staff-recommended alternative would be Alternative No. 2 – Scour Pool & Weir Option.**
- **For Fremont Avenue, the preferred staff-recommended alternative would be Alternative No. 4 – Vertical Slot Fishway Option.**
- **For Stevens Creek Dam and Reservoir, the preferred staff-recommended alternative would be Alternative No. 2 – Multiport Intake Option *(see further explanation in last paragraph below)*.**

For Moffett Boulevard, the ratings of the alternatives for the minor modification and scour pool and weir options were very close to each other. However, the low flow channel option received the higher rating. The low flow channel option would retain the existing structure, but will have to include a passage element for other wildlife species. During normal summer seasons, there would be continuous low flows flowing through the existing Denil fish ladder structure. From the fish ladder structure to U.S. 101, a low-flow fish passage structure would be constructed to ensure continuous low flows from the fish ladder are flushing any sediment build-up that is currently occurring within the fish attractant pool.

For Evelyn Avenue, the scour pool and weir option received the highest rating by a wide margin. Construction of this option would allow continuous unimpeded passage for steelhead and other wildlife species.

Similar to the rating results for Moffett Boulevard, the ratings for the scour pool and weir and vertical slot fishway options received the higher ratings for Fremont Avenue. However, the vertical slot fishway received the highest rating. In a way, if the scour pool and weir option was chosen, there would be an expected significant negative response from the community with regards to removal of approximately 100 mature native trees. Removal of the trees is necessary, since the scour pool and weir option requires the existing east bank to be widened. The vertical slot fishway option would be hydraulically better than the existing Denil structure, because its slope is more gradual. Additionally, the vertical gap opening for this option would help minimize or prevent fish stranding events.

The multiport intake option, which is the only alternative evaluated versus the no project option, received the higher rating. However, although the multiport intake option was selected for Stevens Creek Dam and Reservoir from this study, the Permanent Supplemental Water Supply Systems Project would also evaluate the potential modifications to Stevens Creek Reservoir operations. Therefore, staff recommends that implementation of the multiport intake option be postponed until further evaluation of the other project. The multiport intake option may be included as part of the new project.

4.2 Right of Way for Project Construction

Only improvements to Stevens Creek Dam and Reservoir are located within Water District right of way. Although the majority of improvements for the Moffett Boulevard drop structure are within Water District right of way, there are some improvements within existing easements with the City of Mountain View. Easement agreements will have to be modified and formalized for structural improvements and temporary construction access. Most improvements for the Evelyn Avenue and Fremont Avenue drop structures are respectively within City of Mountain View and City of Sunnyvale easements. The improvement for Evelyn Avenue would also encroach within a UPRR right of way and easement. Easement agreements will also have to be formalized for structural improvements and temporary construction access for the Evelyn and Fremont sites also. For reference, see preliminary right of way maps for all three drop structures, Figures 46 to 48.

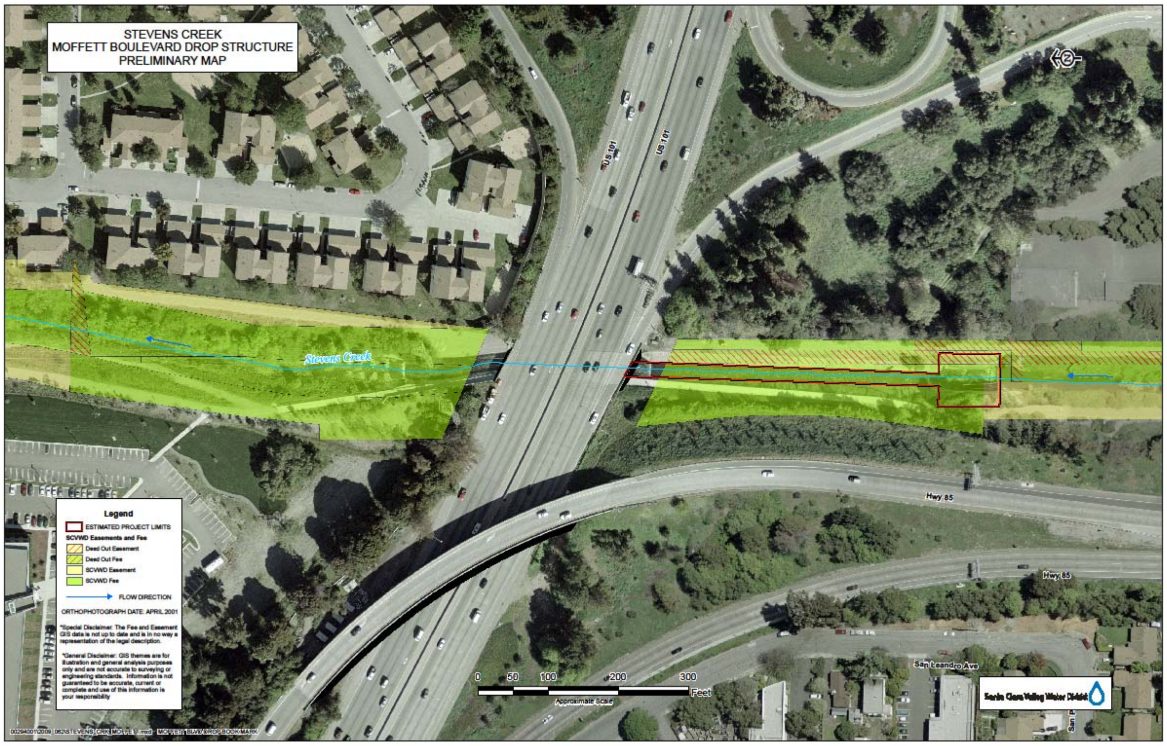

STEVENS CREEK
MOFFETT BOULEVARD DROP STRUCTURE
PRELIMINARY MAP
Stevens Creek
US 101
US 101
Hwy 85
Hwy 85
San Leandro Ave
Legend
ESTIMATED PROJECT LIMITS
SCVWD Easements and Fee
Deed Out Easement
Deed Out Fee
SCVWD Easement
SCVWD Fee
FLOW DIRECTION
ORTHOPHOTOGRAPH DATE: APRIL 2001
*Special Disclaimer: The Fee and Easement GIS data is not up to date and is in no way a representation of the legal description.
*General Disclaimer: GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current or complete and use of this information is your responsibility
0
50
100
200
300
Feet
Approximate Scale
Santa Clara Valley Water District
002940012009_062\STEVENS_CRK_MOFFET.mxd - MOFFETT BLVD DROP BOOKMARK

Figure 50. Preliminary Right of Way for Moffett Boulevard Drop Structure

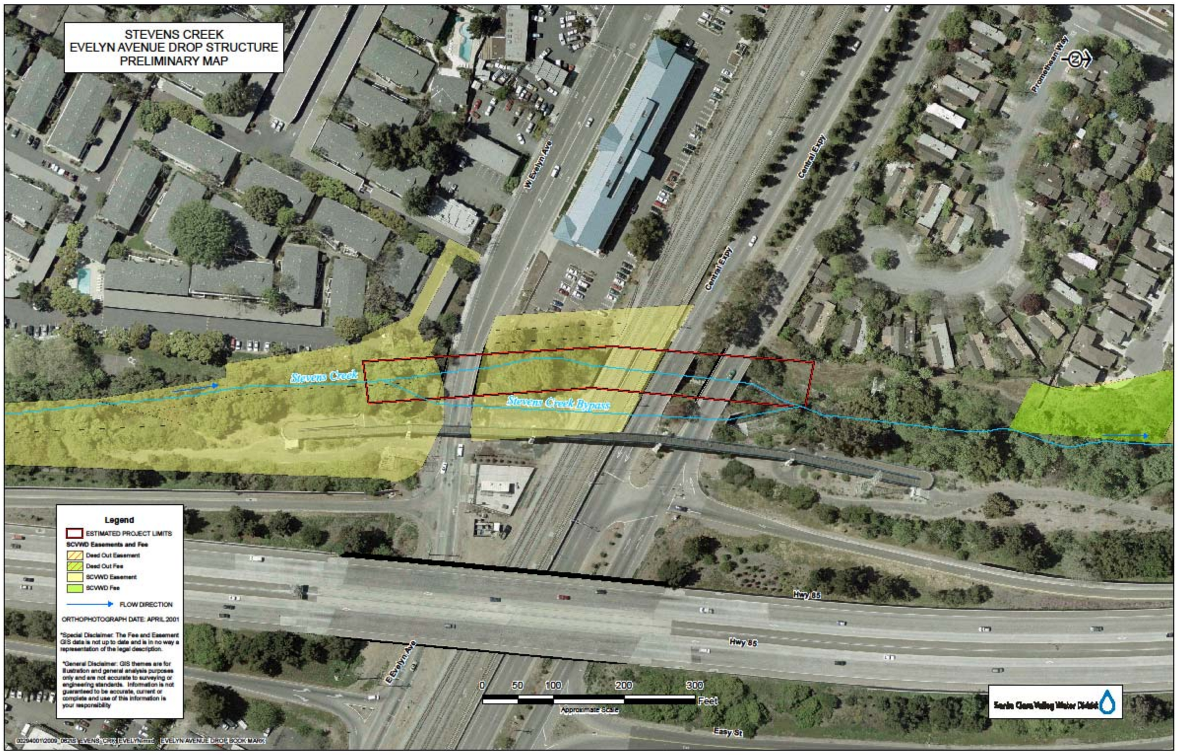

STEVENS CREEK
EVELYN AVENUE DROP STRUCTURE
PRELIMINARY MAP
W Evelyn Ave
Central Expy
Promethean Way
Stevens Creek
Stevens Creek Bypass
Hwy 85
E Evelyn Ave
Easy St
Legend
ESTIMATED PROJECT LIMITS
SCVWD Easements and Fee
Deed Out Easement
Deed Out Fee
SCVWD Easement
SCVWD Fee
FLOW DIRECTION
ORTHOPHOTOGRAPH DATE: APRIL 2001
*Special Disclaimer: The Fee and Easement GIS data is not up to date and is in no way a representation of the legal description.
*General Disclaimer: GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current or complete and use of this information is your responsibility
0 50 100 200 300
Feet
Approximate Scale
Santa Clara Valley Water District

Figure 51. Preliminary Right of Way for Evelyn Avenue Drop Structure

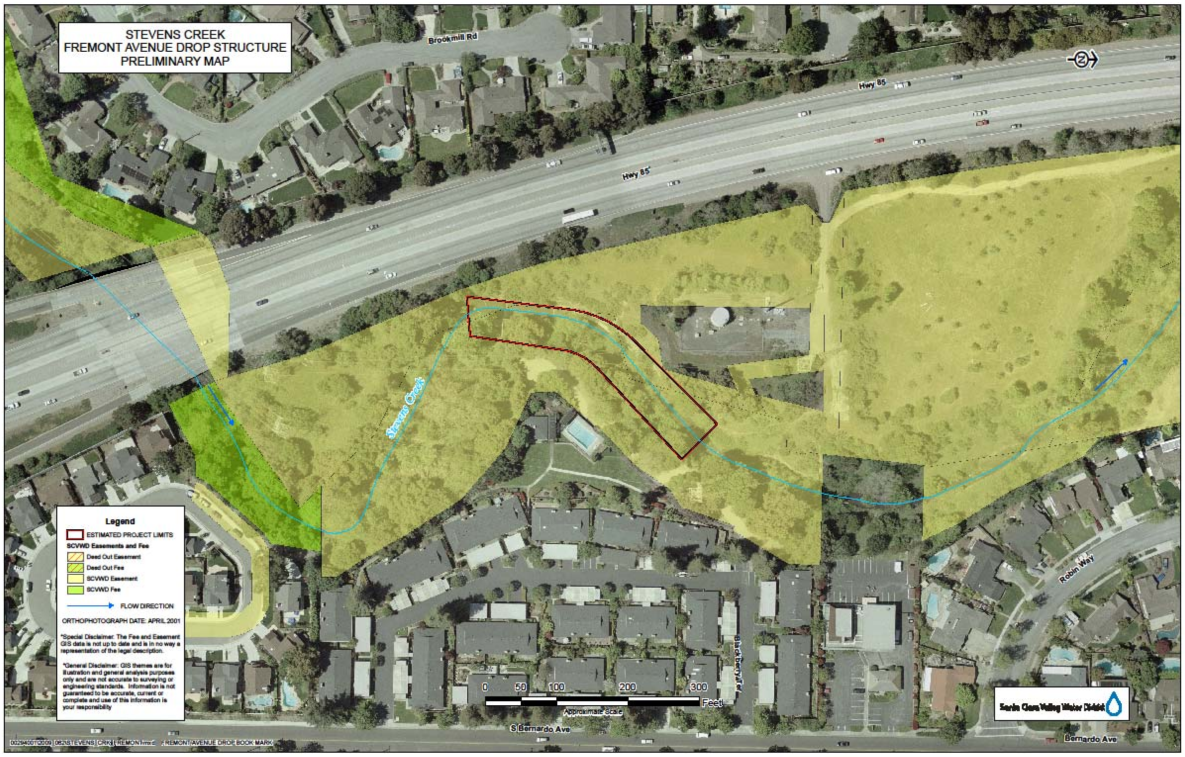

STEVENS CREEK
FREMONT AVENUE DROP STRUCTURE
PRELIMINARY MAP
Brookmill Rd
Hwy 85
Stevens Creek
Robin Way
S Bernardo Ave
Bernardo Ave
Legend
ESTIMATED PROJECT LIMITS
SCVWD Easements and Fee
Deed Out Easement
Deed Out Fee
SCVWD Easement
SCVWD Fee
FLOW DIRECTION
ORTHOPHOTOGRAPH DATE: APRIL 2001
*Special Disclaimer: The Fee and Easement GIS data is not up to date and is in no way a representation of the legal description.
*General Disclaimer: GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current or complete and use of this information is your responsibility
0 50 100 200 300
Feet
Approximate Scale
Santa Clara Valley Water District

Figure 52. Preliminary Right of Way for Fremont Avenue Drop Structure

5.0 CONCLUSIONS AND RECOMMENDATIONS

The main objective of this report was for staff to determine the preferred alternatives for improvement of fish passage at each of three existing fish ladder sites and for the improvement of flow releases from Stevens Creek Dam and Reservoir. For each location, various alternatives were described and feasibly evaluated. A set of criteria was developed to evaluate each of the alternatives in a rating table. Individual team member ratings were obtained, and results were averaged to prevent bias in the ratings. Based on the ratings of the alternatives, the alternative with the highest rating was chosen as the staff-recommended alternative for that site.

Upon acceptable quality review of this report from other team members who were previously identified in the Planning Phase Workplan, staff held a public meeting on November 12, 2009 to receive community and stakeholder feedback on the staff-recommended alternatives. Based on the combined positive support from the community and stakeholders on the recommended alternatives, staff has produced this Planning Study Report for Board’s consideration to adopt a Resolution to consider undertaking this project.

REFERENCES

1. *California Salmonid Stream Habitat Restoration Manual, Part VII, Page 54,* State of California, The Resources Agency, California Department of Fish and Game, Inland Fisheries Division, 1998.

2. Ken Bates, *Fishway Design Guidelines for Pacific Salmon, Pages 5-11 and 5-12,*Washington Department of Fish and Wildlife, 1992.

3. As per Jae Abel, *Fisheries and Aquatic Habitat Collaborative Effort-Technical Advisory Committee discussions/meetings,* Santa Clara Valley Water District, 2003 to 2009.

4. *Fisheries and Aquatic Habitat Collaborative Effort: Summary Report,* Santa Clara Valley Water District, San Jose, California, February 26, 2003.

5. *Anadromous Salmonid Passage Facility Design*, National Marine Fisheries Service (NMFS), Northwest Region, Portland, Oregon, February 2008.

6. *Fish Passes – Design, Dimensions and Monitoring,* Food and Agricultural Organization of the United Nations, in arrangement with Deutscher Verband fur Wasserwirtschaft und Kulturbau e.V. (DVWK), Rome, 2002.

7. Hydrological flow data from Project Delivery, Hydrology & Geotechnical Engineering Unit 355.

8. Design Manual on Open Channel Hydraulics and Sediment Transport, Santa Clara Valley Water District, San Jose, Calif., 2007.